HUMAN DEMOGRAPHIC IMPACTS ON FISH AND WILDLIFE RESOURCES FROM ENERGY DEVELOPMENT IN RURAL WESTERN AREAS

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HUMAN DEMOGRAPHIC IMPACTS ON FISH AND WILDLIFE RESOURCES FROM ENERGY DEVELOPMENT IN RURAL WESTERN AREAS

by

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PREFACE

This workbook presents the findings of Midwest Research Institute under Fish and Wildlife Service Contract No. 14-16-0009-81-067. The research team developed information and procedures for developers, resource managers, and planners to use in project planning as they proceed with quantifying and mitigating the human demographic impacts on fish and wildlife resources that accompany energy development in rapid growth areas.

The workbook provides a mechanism for analysis of human demographic impacts on fish and wildlife due to large-scale energy developments in Western States. It focuses on impacts related to land use conversions and the accompanying reduction in quantity or quality of habitat and on impacts related to population growth and the accompanying demands or impacts on fish and wildlife resources.

The workbook suggests rule-of-thumb procedures for projecting human demographic impacts on fish and wildlife resources due to land use change and population growth, provides guidance on monetary valuation of resources potentially lost, and describes mitigation or enhancement measures that resource managers and planners can consider.

The intended users of the material are developers, resource managers, and planners concerned with protecting the quality of life in rapid growth areas. The workbook was designed for use with proposed coal or oil shale projects, but other energy development can be evaluated if projected work force requirements are known. The workbook is organized as follows:

Section 1 - Introduction - provides an overview of the workbook and a screening table for identifying human demographic impacts.

Section 2 - Demographic Impact Assessment - presents the approach used to generate estimates of new in-migrating human population into an area due to a new energy development project.

Section 3 - Land Use Impact Assessment - provides procedures to quantify and map anticipated land use conversions due to human settlement patterns and relate these conversions to habitat loss or habitat degradation.

Section 4 - Hunting, Fishing, and Other Wildlife-Related Recreation Impact Assessment - provides methods to quantify additional hunting and fishing pressures and impacts from selected nonconsumptive recreational activities.

Section 5 - Poaching Impact Assessment - presents a procedure to forecast poaching increase which will accompany in-migration.

Section 6 - Deer-Vehicle Accident Impact Assessment - presents a procedure to quantify expected losses of big game from vehicle collisions.

Section 7 - Dog Predation Impact Assessment - outlines a procedure to quantify potential losses due to predation by domestic dogs in the vicinity of new development.

Section 8 - Water Use Impact Assessment - reviews potential impacts due to competition for instream flow and impairment of stream quality due to urbanization.

Section 9 - Economic Value Assessment - contains a procedure to quantify values of fish and wildlife affected by human demographic impacts.

Section 10 - Mitigation of Human Demographic Impacts on Wildlife - discusses approaches to prevent adverse effects from land conversion, habitat loss, and adverse impacts of human activities.

Section 11 - Sample Data and Worksheets Based on Dunn County Methanol Plant - presents a set of completed sample worksheets.

Appendices contain further technical and background information as follows:

A. Guidelines for Planning System Entry Points for Fish and Wildlife Concerns
B. Estimating the Demographic Impacts of Energy Development
C. Identifying Potential Conflict Zones
D. Standards for Land Use Conversion
E. Using Mapping Keys and Selecting Evaluation Species
F. Off-Road Vehicle and Snowmobile Use
G. In-migration Impact on Big Game from Illegal Harvest
H. Selected Studies of Deer Mortality on Highways
I. Habitat Enhancement to Compensate for Habitat Loss, Degradation, or Adverse Human Activity Impacts
J. Controlling Adverse Impacts of Regional Development on Water Resources
K. Instructions for the Use of a Contingent Valuation Method
L. Instructions for the Use of a Modified Unit Day Value Method

Assumptions used in developing this workbook are discussed below:

• It is assumed that these procedures will be used by resource managers (Federal and State) working in concert with State, county, and local professional planners and interested citizens. The conceptual framework for these procedures assumes that on-site impacts from a proposed energy facility's construction and operation (e.g., the impacts of mining) are covered in procedures already in use by resource managers.

- It is assumed that the analysis is conducted in the context of a "with project" versus "without project" conceptual framework.

- The user should approach an assessment procedure realizing that the procedure has to be shaped to fit available data. For example, flexibility and creativity will be required if the analyst cannot get study area data that correspond with the demographic projection area (e.g., counties). Each case will be slightly different. Also, many estimators will have to be defined by the analyst because the state of the art of evaluating human demographic impacts on wildlife is so new. Specific methods to generate some of the estimated values needed to apply the procedures are simply not available. It is assumed that where such values are needed, the user will consult experts, review available literature, and document the rationale for selected estimator values wherever possible.

- It is assumed that users with access to site-specific information will develop their own values if sample values suggested in the procedures are not appropriate.

- Even in the absence of energy development projects, it is understood that such factors as current agricultural practices, lack of county land use guidelines, lack of political support for wildlife priorities, shortages of enforcement personnel, etc., are creating some of the same problems addressed in this workbook. There will simply be an acceleration of some impacts. It is hoped that the current focus on rapid growth area needs will encourage a new partnership between industries, local county and community leaders, and public agencies in addressing some of the ongoing, urgent but "low visibility" problems of diminishing habitat.

- Baseline data may not be available to quantify impacts. If the human demographic impact assessment needs can be identified early enough, however, the scope of baseline studies for an environmental impact statement can be adjusted to allow for gathering of data needed for human demographic impact assessment projections.

- Other demographic projection models for in-migration other than the one contained in this workbook may be used. For example, in Colorado and Montana the U.S. Bureau of Land Management has access to user-friendly computer models which can prepare regional population estimates. It is important that the estimates clearly distinguish between the in-migrating population and the workers who come from within the local area, however. Whatever the approach used the final output should produce demographic data on in-migrants by age, sex, year of project, and settlement area.

- The manual does not address the potential for complex, nonadditive cumulative impacts from energy development in the Western States. Ongoing research (Colorado Department of Health and the U.S. Environmental Protection Agency, Region VIII 1981, and Vlachos et al. 1982) is attempting to develop guidance on these impacts.

It is also possible that future human demographic impact assessment may be adaptable to computer models and also computerized land use inventories.

- Background studies used in preparing the worksheets varied considerably. As later workbooks are prepared and data become more refined, it will be possible to give the user more guidance on the statistical reliability of the projections.

- The impact area is generally considered to be a county in this procedure, but more than one county can be addressed and local areas within counties may be the focus of an assessment. The determining factor will be population in-migration and resulting settlement patterns.

- It is recognized that future energy projects are very much a function of exogenous political and economic factors far beyond the purview of most of our resource management institutions. The timing, scale, and location of such projects are greatly influenced by world oil market conditions, government subsidies (e.g., for synfuels projects), State-Federal politics, etc. For example, if the price of oil is relatively depressed, if interest rates are high, and if there is an oil glut, oil shale projects will not be built. Likewise, national economic conditions affecting the demand for synfuels, the price of oil, Federal coal leasing policies, etc., will all influence coal development as well as electrical power generation, synfuels plants, etc. Given an appreciation of the uncertainty of these projects, one can nevertheless consider human demographic impacts of rapid growth in an effort to give fish and wildlife interests maximum lead time for coordination and bargaining in the political arena.

- Any part of the procedures found to be inconsistent with applicable Federal regulations or guidelines should be brought to the attention of the appropriate Federal agency.

SUMMARY

This workbook presents information and procedures to aid resource managers and planners in quantifying and mitigating human demographic impacts on fish and wildlife resources that accompany energy development in rapid growth areas.

This workbook addresses two broad types of impacts. The first category is predominantly habitat-specific. These are impacts related to (a) conversion of land or water use or (b) alteration of habitat value due to human or human settlement-related activities. The land or water use conversions may be a function of urban development around existing or new communities, along linear corridors, or at satellite growth centers in rural areas. In addition to direct loss of land from conversion, impacts which can reduce habitat value include increased levels of human or vehicular activity (which can result in behavioral avoidance or habitat degradation) or increased levels of predation by domestic animals.

The second category of impacts are predominantly habitat-nonspecific. These are impacts which are the result of human demographic changes, but may not be related to changes in habitat values. Examples include hunting, poaching, and road kills. Guidance on quantifying these impacts is offered in the workbook.

Recommendations for future research include:

1. Coordination between wildlife and both development and planning interests to increase public-private partnerships for wildlife enhancement is greatly needed. New tools, such as audio-visual presentations to company employees or landowner participation in increasing access for hunters, need emphasis in mitigation planning.

2. Where disturbances depend on the amount of human activity as well as on the amount of land involved (e.g., oil fields, recreation areas, and rural dwellings), methods are needed for converting the activity factor to a habitat value change measurement so that differences between disturbances can be compared. It is hoped that this workbook will stimulate interest in the subject of human demographic impacts so that factual data will become available for practical use in both wildlife management and land use planning.

3.   Greater state-to-state compatibility in wildlife data (hunting, poaching, road kills) is greatly needed. Assessment of these impacts will be discouraged until this compatibility is achieved.

4.   Wildlife species groups respond differently to human activities based on regularity, consistency, and many other factors; much additional study is needed on these variations.

5.   Further research is needed to determine how crowding impacts the quality of wildlife-related recreational experiences such as hunting and wildlife observation.

6.   An estimate of the effect of wildlife mortalities from human demographic impacts on wildlife populations should be pursued, probably through some form of wildlife population modeling.

7.   Better information is needed on the relationship between changing land use and changing animal populations. More reliable data on yearly population fluctuation, together with improved land use data, may eventually allow analysis of these impacts.

8.   There are instances where important seasonal habitats are very restricted in area. As land use change progressively removes habitat from production, it will be important to monitor the density changes on these seasonal ranges as well as the overall trends of population change.

9.   A stepwise procedure is needed for determining how much "replacement of losses" would be necessary to mitigate for adverse human demographic impacts.

CONTENTS

CONTENTS (Concluded)

FIGURES

FIGURES (Continued)

TABLES

ACKNOWLEDGMENTS

SECTION 1

INTRODUCTION

OVERVIEW OF THE WORKBOOK

The instructions, worksheets, and examples in this workbook are intended to assist the user identify and evaluate selected human demographic impacts on fish and wildlife resources. The workbook is organized to guide the reader through these assessments:

	Section	Worksheet
Demographic Impact	2	1
Land Use Impact	3	2
Recreation Impact	4	3,4,5
Poaching Impact	5	6
Road Kill Impact	6	7
Dog Predation Impact	7	8
Water Use Impact	8	9
Economic Valuation	9	10

Completion of Worksheet No. 1 is essential because all the other worksheets refer to estimates derived directly or indirectly from Worksheet No. 1. Worksheets Nos. 2 through 9 can be completed independently once Worksheet No. 1 is available. Worksheet No. 8 (Predation Impact Assessment) requires prior preparation of Worksheet No. 2. Worksheet No. 10 (Economic Valuation) uses input from any or all of Worksheets Nos. 2 through 9.

There are many sources of declining habitat value related to human settlement activities that the workbook does not attempt to quantify because no useful "desk top" procedure has yet been developed. It is hoped that quantification procedures for additional human demographic impacts can be developed in the future. Examples include impacts from increased firewood cutting and gravel and sand removal. However, there may be cases currently in which such effects can be predicted and localized with confidence by resource managers. In these instances, a user should not feel confined to procedures in this workbook, but should develop assumptions regarding the extent and influence of these impacts in terms of habitat loss or estimated change in habitat values and address potential mitigation of these impacts.

1

GUIDE TO IDENTIFICATION OF HUMAN DEMOGRAPHIC IMPACTS

The resource manager faced with evaluating wildlife impacts from energy development must make some early decisions on the scope and depth of the analysis of human demographic impacts. It is assumed that evaluation of primary impacts of a project's construction and operation will be made largely through an environmental impact statement (EIS). Evaluation of human demographic impacts should also be made a part of the EIS. In order to change the impact of such development on wildlife, however, it is important to strive to make the evaluation an early local priority and a matter of concern for public and private sector community leaders. Guidelines for planning system entry points for fish and wildlife concerns are given in Appendix A.

Impacts across broad groups of species are difficult to accurately address, but data tables can aid in selecting impacts deserving attention or quantification. All assessment procedures are dependent on knowledge of the tolerance and habitat requirements of populations of greatest concern. The tables that follow can be used as a checklist by resource managers and local and State planning professionals working together. A scoping process can be used to focus on selected impacts of greatest concern in a given area and to its residents. These impact tables can also be tailored for use in a visual presentation to energy company employees, local community leaders, private landowners, developers, and others. Table 1 covers big game and upland game/small game; Table 2, furbearers and waterfowl; and Table 3, raptors and other avian species, aquatic species, and common or typical species. Table 4 concludes the section with a summary of categories of human demographic impacts.

The categories of threatened or endangered species or migratory birds of high Federal interest were not included in the tables. It is assumed that such categories would be highlighted as appropriate in any impact analysis procedure. For example, projected changes in stream flow or water quality may become more important in specific situations where threatened or endangered aquatic species may be affected. Air pollution resulting from increased human population in the area was not covered because it was not considered as important a human demographic impact on wildlife as habitat loss and degradation from other sources.

2

Table 1. Human demographic impacts to big game and upland game/small game which can occur in the vicinity of an energy development project.

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Off-site construction			
Linear (corridor) development in the site vicinity excluding plant and mined land):	Erosion and sedimentation, especially from improper construction and maintenance of sediment ponds and roadways. Loss of vegetation.	Sedimentation of important water sources.	
Road: 21 acres/mi of 175 ft ROW 12 acres/mi of 100 ft ROW		Loss of habitat equal to disturbed area. Loss of key habitat will reduce numbers far more than a loss of nonkey habitat.	Loss of resident population.
Transmission line: 18 acres/mi of 230-kV line 12 acres/mi of 138- and 69-kV line		(e.g., riparian habitat in year-long range is critical to deer for fawning and maintenance.)	(e.g., strutting or booming ground, drumming logs, brood use areas or wintering grounds.)
Conveyor system: 10 acres/mi		Loss of localized, usually productive habitats (e.g., wooded stands in otherwise open terrain) will have greater adverse impact.	

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Off-site construction (Cont'd)	Presence of machinery and people.	Support facilities (e.g., conveyor systems) may intersect migration routes; if migration is blocked, severe range overuse may occur. All species will avoid construction activities to some degree. In the absence of shooting, deer and pronghorn will adapt somewhat. Avoidance zones will depend on cover, terrain, level of human activity, and adaptability of of the species. If critical use areas are in avoidance zones, there will be displacement and some reduction of local populations. Critical use areas may include calving and fawning areas, riparian-wetland habitats, winter concentration areas, or any use areas that are limited.	For some species, little or no avoidance in the absence of shooting. Critical use areas may be more vulnerable to behavioral avoidance. For example, sage grouse are likely to abandon strutting grounds within 50 to 1,300 yd of human activity, depending on cover quality and level of human activity. Individual nest sites will also be critical use areas.
Machinery operation.		Toxic materials from petroleum or chemical spills and other machinery accidents can pollute important water sources.	

4

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts		
		Big game	Upland game/small game	

| Off-site operations (Cont'd) | Presence and use of transmission lines and roads. | Lines often encourage human access to key habitat areas. Where transmission line access roads are built in a forest with few roads, the additional access may aid in the hunting of underharvested herds and better herd survival during hard winters. In areas already heavily harvested, new access roads could stress local herds.

Increased access can lead to marginal or submarginal commercial logging operations which will compound vegetation losses. Increased recreational firewood gathering can also be significant, affecting timber along roads within 30 mi of urban areas. | No effects predicted. Potential for enhancement with increased edge. |

5

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Off-site operations (Cont'd)	Transportation systems and vehicle traffic.	Increase in road kills and poaching from roads may impair reproduction in isolated populations. Roads may cross key habitats and migration routes, compounding the problem. Problems are also compounded if work shift changes at energy companies coincide with big game feeding periods. Access into remote areas will increase human recreational activity, usually to the detriment of big game populations. If fenced, rights of way (ROWs) for railroads and highways can severely disrupt big game migrations and result in mortality for individual animals. Populations of elk, mule deer, and pronghorn, for example, will be displaced by vehicle traffic, with elk being the most sensitive, staying about 0.25 mi from traffic compared to about 50 yd for mule deer and pronghorn.	Increase in road kills in proportion to traffic volume but road kills not expected to affect populations unless roads cross or disturb key habitat, e.g., areas important for courtship or brooding. Crucial periods to avoid disturbance will vary by species e.g., sage grouse generally on leks from March 1 to June 15 and brooding/nesting between June 15 and mid-August.)

6

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game

Urbanization

Habitat used for:

Housing, other land uses, roads and ROWs, utilities, airports, reservoirs, second home sites, ski developments, and subdivision of local farms and ranches for low density housing, or "ranchettes."

Secondary effects: Loss of vegetation.

Big game:

Loss of habitat equal to disturbed area. Loss of key habitat (e.g., deer winter range or elk calving areas) will reduce numbers more than a loss of nonkey habitat. Agricultural lands often provide year-long habitat for deer; wetlands and riparian habitats which are normally associated with drainage bottoms (ephemeral or intermittent) or perennial streams, seeps, and springs are all of critical value; such areas are especially susceptible to urbanization impacts.

Long-term impact if urban growth pattern stimulates leapfrog development. Loss of habitat may include all isolated areas between urban pockets due to behavioral avoidance.

Upland game/small game:

Loss of habitat equal to disturbed area. Loss of key habitat (e.g., strutting or booming grounds, drumming logs, brood use areas or wintering grounds) will reduce numbers more than a loss of nonkey habitat.

Wetlands and riparian habitats which are normally associated with drainage bottoms (ephemeral or intermittent) or perennial streams, seeps, and springs are of critical value to many species.

Cropland can provide for all the requirements of some species for food and cover (e.g., pheasant); loss of cropland will reduce local populations.

7

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Urbanization	Loss of vegetation.	With intrusion into habitat, human/wildlife conflicts will increase. Big game can become a significant problem for crops, gardens, and ornamental plants. Such conflicts may even result in damage payments (depending on state laws). Costly removal of offending animals or population reductions may be necessary. Particularly on the plains, loss of winter range with riparian habitat can reduce local deer and elk populations. These riparian habitats in year long or summer range are of critical value for calving and maintenance of deer, elk, and moose populations. Within the Rockies, elk in particular get their food from south facing slopes and windblown ridges. Development on these winter range areas may be even more critical than riparian areas.	"Pest" wildlife conflicts with humans may increase (e.g., complaints over skunks, raccoons, etc.) forcing costly removal of animals.
Gravel and sand removal	Loss of riparian vegetation.	Loss of habitat equal to disturbed area. Riparian habitats are generally the most valuable and in shortest supply of all habitat types.	

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Urbanization (Cont'd)			
	Timber sales.	Increased timber sales may have a positive or a negative impact on wildlife populations, depending on the management of the timber program, i.e., whether there is an established schedule of harvest to provide a sustained yield of forest resources. Wildlife species that feed by browsing may benefit while species requiring cover may be adversely impacted. A typical commercial firewood enterprise can harvest 5,000 cords of wood a year. Furthermore, an increase in roads can open backcountry areas to recreationists and others who intentionally or unintentionally harass sensitive species.	Disturbance of any key habitat can be critical to local populations (e.g., sage grouse are likely to abandon strutting grounds within 50 to 1,300 yd of human activity, depending on cover quality and level of human activity).
	Presence of machinery and people.	All species will avoid areas of human activity to some degree. In the absence of harassment, some individuals (deer, pronghorn) may adapt and return to the area. Permanent avoidance zones will depend on the terrain, habitat quality, level of human activity and the adaptability of the species.	
	Increased competition for in-stream flow.	Loss or modification of a water supply and associated vegetation can eliminate resident populations and reduce area populations if stream courses are used by wildlife for water, escape cover, food, and/or corridors for movement. Reduction of	Population reduction if water sources lost. Greatest reductions expected for quail, doves, and chukar. Lowered water tables can have devastating impacts on riparian vegetation in hardwood draws, which are very critical habitat in the Northern Great Plains. Greatest impacts

9

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts		
		Big game	Upland game/small game	

Urbanization
(Cont'd)

Increased competition for instream flow (Cont'd).

Big game: instream flow during critical spring months may result in loss of some individuals. In the case of threatened and endangered species, continued existence may be jeopardized. Lowered water tables can have devastating impacts on riparian vegetation in hardwood draws, which are critical habitat. For big game in the Northern Great Plains, greatest impacts would be on white-tailed deer and mule deer.

Upland game/small game: would be on sharp-tailed grouse and pheasant. Potential enhancement of some areas possible with installation of artificial water systems.

Population reduction if water sources dry up. Greatest reduction expected for quail, dove, and chukar. Wastewater treatment lagoons could attract doves and quail.

Water supply reservoir.

Big game: Loss of habitat equal to inundated land area. Loss of key habitat such as wetlands and riparian habitats will reduce numbers more than loss of nonkey areas (e.g., riparian habitat in year-long range is critical to deer for fawning and maintenance).

Introduction of domestic pets and livestock.

Big game: Dogs running in packs are likely to harass and kill deer and pronghorn. Dogs will occasionally take a lone elk. Dogs belonging to workers at rig sites and camps are a special concern. Cattle are a serious competititor with big game in dry areas.

Upland game/small game: Dogs and cats harass and kill upland game species, particularly the young, and particularly waterfowl species. Predation most intense near settlements.

10

Table 1 (Continued)

Project parameter	Secondary effects	Potential impacts	
		Big game	Upland game/small game
Human recreation	Hunting.	Increased hunting pressure may require changes in management policy (e.g., reduced bag limits or reduced seasons) to maintain population levels. May result in closure of some private lands to hunting. Reduced quality of the experience will occur at some stage of crowding.	Increased hunting pressure. If exceedingly great, it may require changes in management policy, such as reduced bag limits or reduced seasons to maintain population levels. May result in closure of some private lands to hunting. Reduced quality of the experience will occur at some stage of crowding.
	Off-road vehicle (ORV) use.	Soil and vegetation disturbance and erosion from trails can change forage quality and quantity. All species avoid areas with heavy ORV use.	Changes in vegetation resulting from soil disturbance may cause local population declines. Most species will avoid ORV use areas. Major reduction in sage grouse populations if ORVs use key habitat.
	Snowmobile use.	Increased stress from noise, visual disturbance, and pursuit of game by snowmobilers may result in mortality of some individuals in weakened condition. Increased winter access may increase frequency of poaching. Snowmobiles and even ORVs are sometimes used to drive animals to hunters or provide access to previously remote areas.	No effects predicted.

11

Table 1 (Concluded).

		Potential impacts	
Project parameter	Secondary effects	Big game	Upland game/small game
Human recreation (Cont'd)	General recreation.	Concentrated activities in big game habitat can displace local populations. Recreation at water sites can reduce use by pronghorn and bighorn.	Human use of watering areas can reduce use by upland game.
Human illegal activities	Poaching.	Potential for decrease in local populations; poaching may equal legal harvest. Deer are most often poached because of their abundance. Road hunting will likely be a bigger problem than night hunting where town-to-mine routes traverse key areas for deer during early morning and late evening feeding periods. Night hunting will be a bigger problem on roads in previously rural areas, near settlements. Small local populations of bighorn or elk may be reduced due to poaching.	No effects predicted.

Source: Midwest Research Institute.

12

Table 2. Human demographic impacts to furbearers and waterfowl which can occur in the vicinity of an energy development project.

Project parameters	Secondary effects	Potential impacts	
		Furbearers	Waterfowl
Off-site construction			
Linear (corridor) development in the vicinity (excluding plant and mined land):	Erosion and sedimentation, especially from improper construction and maintenance of sediment ponds and roadways.	Population reduction if prey abundance declines due to loss of water sources.	Sedimentation of water bodies can reduce their use by waterfowl if vegetation or invertebrates that waterfowl eat are destroyed. Sediment accumulation can reduce surface area and degrade habitat. Smaller areas may be completely filled in.
Road: 21 acres/mi of 175-ft ROW			
12 acres/mi of 100-ft ROW			
Transmission line: 18 acres/mi of 230-kV line and 69-kV line	Loss of vegetation.	Loss of habitat equal to disturbed area and loss of resident populations. Loss of key habitat structures will reduce numbers more than a loss of nonkey habitat (e.g., beaver lodges or bank dens are critical to maintenance of beaver populations).	Loss of wetlands, water bodies, or aquatic vegetation may reduce waterfowl numbers in the local area.
Conveyor system: 10 acres/mi		Loss of localized or unusually productive habitats (e.g., riparian zones or isolated wooded stands) will have an adverse impact. Population reduction also occurs if suitable prey sources (small mammals and reptiles) are lost and predators are food-limited.	

13

Table 2. (Continued)

Project parameters	Secondary effects	Potential impacts	
		Furbearers	Waterfowl
Off-site construc-tion (Cont'd)	Presence of ma-chinery and people.	All species expected to avoid construction activity, though some (badger, skunk, otter) will often adapt and return to suitable habitat near con-struction sites. A critical period to avoid harassment of all furbearers is when they have young in a nest, den, or lodge. It is also crucial not to harass bobcat, lynx, and cougar females accompanied by young.	Over time, and in the absence of shooting, little avoidance by most species, unless human activities occur adjacent to water.
Off-site operations	Presence and use of transmission lines and roads.	No effects predicted. New access into remote areas can disturb critical use areas of threatened or endangered species (e.g., grey wolf).	Collisions with wires can occur with migrating birds or birds flushed from water.
	Transportation systems and vehicle traffic.	Increase in road kills in proportion to traffic volume increase. Highway mortality may already be a significant source of death for some species.	No effects predicted.

14

Table 2. (Continued)

Project parameters	Secondary effects	Potential impacts	
		Furbearers	Waterfowl
Urbanization			
Habitat used for: Housing, other land uses, roads and rights-of-way, air-ports, reservoirs, utilities, second home sites, ski de-velopments, and sub-division of local farms and ranches for low density housing, or "ranchettes."	Loss of vegetation.	Loss of habitat equal to dis-turbed area. Little effect on populations unless urban uses disturb key habitat areas, or dispersed rural settlements reduce riparian habitat. Long term implications if ur-ban growth stimulates leap-frog development. Develop-ment sites are often near riparian areas; degradation of riparian zones will mean loss of habitat equal to dis-turbed areas. Local popula-tions may be lost.	Loss of aquatic vegetation may reduce waterfowl numbers. Loss of agricultural land producing corn or other small grain crops may reduce geese and dabbling duck populations locally. Loss of aquatic vegetation in streams degraded by urban runoff and pollutants may reduce waterfowl numbers locally. Loss of riparian zones may reduce resting sites.
	Gravel and sand extraction.	Loss of riparian habitat equal to disturbed area. Riparian habitats are generally the most valuable and in shortest sup-ply of all habitat types.	
	Presence of machinery and people.	All species will avoid human activity, though some species will inhabit areas rela-tively near development if habitat is good and the ani-mals are not harassed.	Avoidance if developments occur adjacent to water. For waterfowl that nest lo-cally, the period March 15 through June 15 is crucial to the maintenance of most

15

Table 2. (Continued)

Project parameters	Secondary effects	Potential impacts	
		Furbearers	Waterfowl
Urbanization (Cont'd)	Presence of machinery and people (Cont'd).		populations. After that, riparian and wetland habitats represent high-priority brooding areas, and cover protection during the adults' flightless period is important.
	Increased competition for instream flows.	If riparian habitat is altered from changes in the flow regime, there will be a habitat loss equal to the disturbed area. Reductions in populations will result if prey species abundance is reduced. Loss of flowing water will eliminate some local populations (e.g., beaver).	Loss of aquatic vegetation in streams with altered flow regimes may reduce waterfowl numbers. Local population may also decline if water bodies are reduced in size or if water quality is degraded. Potential for enhancement exists if permanent pond or lake habitats are created in areas where precipitation exceeds evaporation.
	Water supply reservoir.	Loss of riparian habitat equal to inundated area.	Potential benefit to waterfowl as resting area during migration.
Human recreation	Hunting.	Increased hunting pressure proportional to number of in-migrants. May require changes in management policy such as reduced trapping limits or seasons to maintain population levels.	Increased hunting pressure proportional to number of in-migrants. May require changes in management policy such as reduced bag limits or seasons to maintain population levels.

Table 2. (Concluded).

Project parameters	Secondary effects	Potential impacts	
		Furbearers	Waterfowl
Human recreation (Cont'd)	ORV use.	Change in vegetation resulting from soil disturbance will affect furbearers through loss of cover or prey items. Many species will avoid ORV use areas.	ORV use at water areas, such as springs and ponds, will degrade quality of areas for waterfowl.
	Snowmobile use.	Increased legal and illegal harvests due to improved access.	No effects predicted.
	General recreation.	No effects predicted.	Human use of water bodies may reduce use by waterfowl.
Human illegal activities	Poaching.	Poaching likely for most species but with little reduction of overall population.	Waterfowl poaching expected; little reduction of population, however.

Source: Midwest Research Institute.

17

Table 3. Human demographic impacts to raptors and other avian species, aquatic species, and common or typical species which can occur in the vicinity of an energy development project

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Off-site construction			
Linear (corridor) development in the site vicinity (ex-cluding plant and mined land): Road: 21 acres/mi of 175-ft ROW 12 acres/mi of 100-ft ROW	Erosion and sedi-mentation, espe-cially from im-proper construc-tion and mainte-nance of sediment ponds and roadways.	Population reduction may occur if prey abundance declines due to deterioration of water sources. Accelerated bank erosion due to road construc-tion near streams can elimi-nate key perching or resting sites. Dirt bank habitats along riparian areas are of critical value to birds which nest along stream banks.	With sedimentation, local aquatic populations may be reduced. Loss of spawning areas will reduce game fish numbers more than loss of nonkey habitat. Major prob-lems can stem from construc-tion where roads cross or parallel streams and cause siltation, accelerated bank erosion, diminished food supply, or elevated tempera-tures.
Transmission line: 18 acres/mi of 230-kV line 12 acres/mi of 138- and 69-kV line Conveyor system: 10 acres/mi	Loss of vegetation.	Loss of habitat equal to dis-turbed area. Loss of key habitat (e.g., cavity trees are critical to several spe-cies) will reduce numbers more than a loss of nonkey habitat. Also, loss of localized or un-usually productive habitat (e.g., wooded stands in other-wise open terrain) will have great adverse impact. Popula-tion reduction also possible if prey sources (small mammals and reptiles) are lost and preda-tors are food-limited or require a prey base within a given dis-tance from breeding areas.	Direct mortality of nonmobile fish and wildlife species with loss of riparian habitat and stream courses. Loss of vegetation near water bodies can result in raised water temperatures and reduced lo-cal populations of some spe-cies. Loss of vegetation near water bodies can lead to increased erosion and siltation.

18

Table 3 (Continued)

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Off-site construction (Cont'd)	Presence of machinery and people.	Behavioral avoidance by raptors and eagles may occur. Disturbance near key habitat (e.g., cliffs and tallus areas) is especially detrimental.	No effects predicted for aquatic species. Some avoidance by medium-sized mammals will occur.
	Transmission lines.	Birds of prey, especially eagles, may be electrocuted on wires. On the other hand, properly constructed lines may provide nest sites for some raptors. Shooting of eagles and hawks along ROWs may increase.	No effects predicted.
Urbanization Habitat used for: Housing, other land uses, roads and ROWs, airports, reservoirs, utilities, second home sites, ski developments, and subdivision of local farms and ranges for low density housing, or "ranchettes."	Loss of vegetation.	Loss of habitat equal to disturbed area. Partial or total loss of home range for some individuals; local populations may be reduced. Eagle populations are probably far more threatened by accelerating loss of appropriate habitat than by direct or indirect forms of harassment. Wetlands and riparian habitats normally associated with drainage bottoms (ephemeral or intermittent) or perennial streams, seeps, and springs are of critical value.	Loss of vegetation near streams can result in raised water temperatures and elimination of some local populations. Water pollution and siltation expected to increase with loss of buffer zones near water bodies.

19

Table 3 (Continued)

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Urbanization (Cont'd)	Loss of vegetation (Cont'd).	Many avian species nest on the ground near wetland areas or riparian habitats. Such areas are especially susceptible to urbanization.	
		A change in prey species may lead to a change in raptor and other avian species.	
	Gravel and sand extraction.	Loss of riparian habitat equal to disturbed area. Riparian habitats are generally the most valuable and in shortest supply of all habitat types.	
	Presence of machinery and people.	For some raptors (e.g., red-tailed hawk) little long term avoidance in the absence of shooting and human disturbance in key habitats for nesting. However, avoidance zones may be quite large for some raptors (e.g., 0.6 mi for golden eagle). Some individuals may acclimate if raised near disturbance or gradually introduced to it.	Most species will avoid human activity to some extent, but this is not expected to be a major impact.
	Increased competition for instream flows, community utilities.	Predator populations may decline if prey populations are reduced due to water impacts.	Fluctuation in stream flow may negatively affect reproduction and wintering of many fish species. If instream flow requirements of existing fisheries are not met, local populations may be eliminated.

20

Table 3 (Continued)

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Urbanization (Cont'd)	Increased competition for instream flows, community utilities (Cont'd).		Change in stream flow regime and/or water quality may affect aquatic invertebrates. Disturbance may result in reduction in diversity and the number of organisms in the benthic community, generally in relation to the severity of the water quality degradation. Discharge of polluted effluents into local waters could adversely impact local fisheries either directly or by changing the forage base.
			Some species may be attracted to disposal sites. Rats, ravens, gulls, house mice, and some types of snakes may replace native species in the vicinity of sites.
	Water supply reservoir.	Inundation of riparian habitat may eliminate nest trees. Soils surrounding new high water mark may not support development of new trees.	Any reduction in peak flows can result in localized sediment buildup, water temperature changes, and other chemical changes potentially adverse to endemic fish species. Dams may prevent fish from migrating and thereby isolate populations. Releases must be designed to meet key flow needs based on normal plus wet, dry, and critically dry water years.

21

Table 3 (Continued)

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Urbanization (Cont'd)	Water supply reservoir (Cont'd).		Elimination of higher than normal summer flows may eliminate backwater nursery areas, resulting in lowered reproductive success and increased disease and predation.
	Introduction of domestic pets and increased livestock grazing.	Domestic and feral cats prey on ground nesting birds, and cats may be significant competitors with rodent-eating raptors, especially in raptor concentration areas (e.g., wintering areas). Livestock can degrade riparian zones needed by birds for nesting. For example, regeneration of cottonwoods along rivers can be difficult if livestock grazing is allowed, particularly if flow levels are artificially controlled by dams.	No effects predicted. If over grazing occurs, potential exists for degradation of riparian areas, siltation and sedimentation of streams, and associated adverse impact on local fisheries.
		Conversion of brushland to grass for cattle pasture may adversely affect some raptor species by disrupting the traditional prey base of jackrabbit, other lagomorphs, ground squirrel, and other rodents.	No effects predicted.

22

Table 3 (Concluded).

Project parameters	Secondary effects	Raptors and other avian species	Aquatic species and common/typical species
Urbanization (Cont'd)	Firewood cutting.	Reduction in snags and seasonal disturbance may reduce habitat and result in harassment of some species.	No effects predicted.
Recreation	Hunting.	Waterfowl hunting in bald eagle wintering areas is likely to be detrimental to eagles.	No effects predicted.
	Fishing.	No effects predicted.	Increased fishing pressure proportional to increased human population. May require changes in management policy, such as reduced limits or seasons. At some level of use, crowded conditions could reduce the quality of the experience.
	ORV use.	ORV use near sensitive species during breeding seasons may reduce raptor populations. Certain species abandon nests if disturbed during the nesting season. Changes in vegetation in heavy use areas will reduce local songbird populations.	For terrestrial species, changes in vegetation resulting from soil disturbance can result in loss of cover and food. Noise may cause avoidance by some species. Some individuals probably will be run over. No effects predicted for aquatic species.

Source: Midwest Research Institute.

23

Table 4. Summary of key categories of human demographic impacts.

Habitat removal

Central site expansion: This includes the population growth and associated land and water use conversions to housing, commercial, industrial, transportation, and related urban uses that occur in rapid growth areas.

Central site sphere of influence expansion: This includes land and water use conversion to accommodate satellite facilities commonly found close to towns, for example, airports, solid waste disposal sites, water supply reservoirs, wastewater treatment plants, sand and gravel quarries, stock yards, recreation areas, and cemeteries. With growth there will be expansion of some facilities and new development of many others.

Rural dispersed sites: These include rural subdivisions, trailer courts, ranchettes, outlying recreation developments or recreational housing, and various new economic activity centers, such as gas and oil field exploration, timber operations, and peripheral mining.

Linear facilities: These include all highway or rail corridors emanating from communities, mines, or rural dispersed sites; utility corridors; and pipelines. Such linear facilities are usually accompanied by a network of access or service roads.

Habitat degradation

Water quality: This may decline as a result of many influences, including construction runoff, hydrologic modification in urbanizing areas, and sand and salt pollutants from road maintenance. For rapid growth areas most towns cannot expand wastewater treatment systems in time to meet new demand. For a few years raw sewage may flow into local streams from overloaded treatment plants, polluted groundwater from leaks in pipelines or overloaded septic tanks, or dumping from campers and mobile homes. Chemicals used for mosquito control, herbicides, fertilizers, and other urban chemicals (e.g., motor oil) may find their way into surface waters.

Noise, herbicide application, loss of vegetation, and soil compaction due to human overuse of areas, stream bank erosion from increased urban runoff, loss from overuse by domestic animals, and increased human presence: All of these are examples of ways in which the quality of terrestrial or aquatic habitat can be reduced. Reducing habitat quality reduces the number of animals an area can support or changes the kinds of animals that can survive in the area.

Illegal waste disposal: This can be a severe problem if there is no qualified landfill to accept industrial wastes (e.g., motor oils, chemicals, and dry cleaning fluids) from new service industries. Leachate from existing solid waste disposal sites can become a long term pollution source. There may also be ad hoc dump sites for junked cars and miscellaneous trash.

Table 4 (Continued)

Direct mortality

Illegal hunting: This can be significant, and an economic slump may bring an even greater wave of poaching for meat. Illegal shooting of nongame birds and mammals may increase.

Road kills: These will depend on the location of roads in relation to big game herds and migratory routes, traffic volume, and other factors. In some problem areas, road kills may exceed all other causes of mortality combined.

Predation: Predation of big game by uncontrolled dogs can be a serious problem in the winter if residences are near winter ranges, particularly if fences create a barrier to wildlife. Energy exploration crews may also own dogs that kill wildlife. Cats, rats, and other species that accompany human development often become important predators on native species.

Recreation: Increased demand for hunting and fishing will occur. Though wildlife populations may not be jeopardized, the quality of the experience may be reduced.

Harassment

Unintentional: Harassment of wildlife may result from the unintentional disturbance of animals or simply from the increased presence of humans in previously undisturbed areas. Although many species are relatively tolerant of human presence, adverse effects can occur to most animals if they are disturbed during times of stress, such as during a severe winter, or at a critical time of the year, for example, during the breeding season. Some species are intolerant of human presence and may be lost from an area entirely if human activity increases.

Recreational activities, such as hiking and camping as well as hunting or fishing, that take place in remote areas will create some disturbance to wildlife. Some species become tolerant of human presence; others do not. Even photographers can unintentionally harass wildlife when, for example, they become skilled at seeking out nest sites or young animals. Use of off-road recreational vehicles or snowmobiles can be a major source of disturbance to many species.

Intentional: Deliberate harassment of animals by humans will occur to some degree. Such harassment may be one by-product of the stress in rapid growth areas, stress which finds many socially undesirable outlets. Harassment and killing of animals may include chasing animals on trail bikes or snowmobiles and thrill shooting from moving vehicles.

Table 4 (Concluded).

Barrier construction

Roads, fences, and other structures may create barriers to wildlife movement.

Introduction of superior competitors

New species often accompany human development which are able to out-compete native species as the land use changes from rural to urban.

SECTION 2

DEMOGRAPHIC IMPACT ASSESSMENT

INSTRUCTIONS FOR A DEMOGRAPHIC IMPACT ASSESSMENT (WORKSHEET NO. 1)

This procedure addresses the generation of human demographic impacts, i.e., the number, demographic profile, and residential location of the new population that can be expected to enter an area with a new energy development project. Such analyses are typically prepared for energy development projects, with collaboration between planners, sociologists, and economists. However, the results of such analyses may be available to biologists too late in the project planning to allow use of the analyses for detailed human demographic impact estimation. Also, the format of these data may not be consistent with other impact worksheets (in terms of age and sex profiles of in-migrants, for example). Therefore, it is useful for the biologist to be able to readily prepare his or her own demographic impact assessment. The assessment uses the following steps:

Step 1 - Projecting direct employment

Step 2 - Estimating secondary employment

Step 3 - Estimating the in-migrating fraction of workers

Step 4 - Constructing a population profile of in-migrants

Step 5 - Projecting residential location of in-migrants

Steps 1 and 2 of Worksheet No. 1 should be completed for all years of the project construction period and the first several years of project operation. Unless population estimates are desired for each year, it will not be necessary to complete the succeeding steps for all years. However, at a minimum, Steps 3 and 4 should be completed for the year of peak construction activity and for a typical year (with respect to employment level) after construction has been completed.

Worksheet No. 1 begins on page 32. Representative data and an example Worksheet No. 1 are found in Section 11.

27

<u>Step 1</u> - Projecting Direct Employment

    Line 1 - Operations (Permanent) Employment:
        Enter estimated average employment for the peak quarter (3-month period with highest employment). Operations employment should be computed first because of the maximum constraint on construction-related secondary employment in Step 2. Employment information is generally available from the developer. If such information is unavailable or as a check on estimates obtained, see Appendix B, Table B-1.

    Line 2 - Construction (Temporary) Employment:
        As in Line 1, enter average employment for the peak quarter. For comparison values, see Appendix B, Table B-1.

<u>Step 2</u> - Estimating Secondary Employment

    Line 1 - Operations-Related Secondary Employment:
        Select a multiplier value which appears appropriate for the type of project, impact area characteristics, and level of analysis. The following suggested ranges of values appear appropriate for most Western energy projects. The higher values in each range would be appropriate for projects with high levels of local expenditures or areas with relatively diverse, self-sufficient economies.

Impact area characteristics	Level of analysis	Construction phase	Operation phase
Rural, sparsely populated, no large trade center within impact area	Region County	0.3-0.7 0.2-0.4	0.5-1.2 0.3-0.6
More urbanized impact areas, moderate population densities	Region County	0.4-0.8 0.3-0.5	0.6-1.3 0.4-0.8
On fringe of metropolitan area	Region County	0.5-0.9 0.4-0.7	0.7-1.5 0.6-1.2

    Line 2 - Construction-Related Secondary Employment:
        The typical values provided above should assist in selecting a multiplier value. Note the constraint that construction-related secondary employment should not exceed operations-related secondary employment (computed as the average level of secondary employment for the first 2 yr after construction ends).

<u>Step 3</u> - Estimating the In-migrating Fraction of Workers

This step is completed for each year for which estimates of project-related population are desired, generally at least for the peak year of construction activity and a typical year of project operation. For more discussion of the following instructions, see Appendix B.

Line 1 - From Step 1, Line 2.

Line 2 - The value to be estimated is the fraction of the construction work force which will be local workers. Past studies indicate that this value will fall in the range of 0.3 to 0.5 (30 to 50 percent) for most Western energy projects, with 0.4 being a typical value. Interviews may be conducted with company managers and personnel supervisors to verify estimates in light of local conditions and project plans.

Line 3 - The value to be estimated is the fraction of the construction work force which will be single or will commute to the study area on a weekly basis (leaving their families at a permanent residence elsewhere). Past studies indicate that this value will fall in the range of 0.2 to 0.4 for most Western energy projects, with 0.3 being a typical value. (Note: In comparing values shown here with those shown in Appendix B, bear in mind that worksheet values refer to percentage of total construction work force while Appendix B values refer to percentage of in-migrating construction work force.)

Lines 4-6 - See worksheet calculation.

Line 7 - The value to be estimated is the number of children associated with each in-migrating construction worker family. The suggested value (1.4 children per family) was derived from surveys at a number of construction sites. The same value is used for operation and secondary worker families.

Line 8 - From Step 1, Line 1.

Line 9 - The value to be estimated is the fraction of the operations (permanent) work force that will be made up of local workers. Past surveys of Western energy projects suggest that the most typical values are in the range of 40 to 70 percent (i.e., 0.4 to 0.7). For additional discussion, see Appendix B, Table B-4. Again, interviews with personnel supervisors are useful to verify the selected value.

Line 10 - See worksheet calculation.

Line 11 - The value to be estimated is the fraction of in-migrating operations workers who will be married. Past studies indicate a range of 0.7 to 0.8, with 0.8 being a typical value.

Lines 12-13 - See worksheet calculation.

29

Line 14 - As in Lines 2 and 9 above, the value to be estimated is the fraction of the project-related secondary jobs that will be filled by local workers. Past surveys of Western energy projects suggest the range is 0.5 to 0.7, with 0.6 being typical.

Line 15 - The value to be estimated is the percentage of the project construction and operations workers' spouses who will be available for employment in secondary jobs. Past studies indicate a range of 0.2 to 0.4 for this value, with 0.3 being a typical value.

Line 16 - See worksheet calculation.

Line 17 - The value estimated is the percentage of local construction and operations workers who represent jobs which have been vacated and which will be filled by in-migrating replacement workers.

Line 18 - See worksheet calculation.

Line 19 - The value to be estimated is the fraction of the in-migrating secondary workers who are single (including those divorced or widowed). Past studies indicate a range of 0.2 to 0.3, with 0.2 being typical.

Line 20 - The value to be estimated is the average number of employed adults per in-migrating secondary worker family. The suggested value (1.4) implies that 40 percent of such households will have two employed adults, i.e., that 40 percent of spouses are employed.

Lines 21-23 - See worksheet calculation.

Step 4 - Constructing a Population Profile of In-migrants

As with Step 3, this step is completed for each year for which estimates of project-related population are desired.

Line 1 - Because the construction work force is made up primarily of male workers, all in-migrating construction workers are assumed to be males.

Lines 1a-1d - The standard values are derived from extensive surveys of construction work forces at Western energy projects (see Appendix B, Table·B-5).

Line 2 - All spouses of in-migrating construction workers are assumed to be female.

Line 3 - Construction workers' children are assumed to be equally divided between males and females.

Lines 4a-4f - Again, the standard values are derived from surveys of work forces at Western energy projects (Appendix B, Table B-5).

Lines 5a-5b - Survey data indicate that 90 percent of project operations workers will be male.

Lines 5c-5f - Values are derived from survey data.

Line 6 - The standard value implies that 90 percent of operations workers' spouses will be female.

Lines 7-8 - See worksheet calculation.

Lines 8a-8b - Survey data indicate that 60 percent of secondary workers will be male.

Lines 9-10 - See worksheet calculation.

Lines 11-13 - This population summary table allows summarization of the project-induced in-migrating population by worker type (i.e., occupation of household head). Remember that values computed below Lines 4, 7, and 10 (of Step 4) must be entered twice (male and female children).

Step 5 - Projecting the Residential Location of In-migrants

This step provides for allocation of project-related in-migrating population and project-related workers (households) to specific communities in the study area. Allocations may be computed for all segments of the study area or, alternatively, only for selected towns or counties of special interest. These computations will be performed only for the years for which Steps 3 and 4 have been completed.

Step 5a - Allocation of the population to each community can be approached in several ways. Local planners and others close to the situation will often have strong opinions concerning the relative attraction of various area communities for the new population. Similarly, the analyst may be sufficiently familiar with the area to feel confident in making judgmental estimates of community shares. Alternatively, a gravity model approach can be utilized, and the shares as estimated through the gravity model may be subsequently modified to account for community-specific factors, if desired. Appendix B provides sufficient explanation of a modified gravity model approach to allow an allocation of new population to area communities.

Steps 5b-5c - See worksheet calculation.

Step 5d - Baseline population projections are assumed to be available from secondary sources. Should such estimates not be available, see Appendix B for sources concerning estimation methods.

31

Worksheet No. 1

DEMOGRAPHIC IMPACT ASSESSMENT

Step 1 - Projecting Direct Employment

Year	1	2	3	4	5	6	7	8

1. Operations (permanent)
    employment

2. Construction (temporary)
    employment

Step 2 - Estimating Secondary Employment

Year	1	2	3	4	5	6	7	8

1. Operations-related
    secondary employment
    (operations work force x____)
    (write in estimated multiplier
    value)

2. Construction-related secondary
    employment[a] (construction work
    force x___)(write in estimated
    multiplier value)

3. Total secondary employment
    (sum of Lines 1 and 2)

---

[a] May not exceed operations-related secondary employment (average for first
2 years after construction ends).

32

Step 3 - Estimating the In-migrating Fraction of Workers   Year   Year
                                                          ____   ____

Construction Workers and Dependents

1. Total construction workers = _____
    (from Step 1, Line 2)   ____   ____

2. Local workers = $\overline{(0.3-0.5)}$ $\dfrac{value}{\rule{2em}{0.4pt}}$ x Line 1
                          range
    = _____ workers   ____   ____

3. Single workers and   range   value
    weekly commuters   = $\overline{(0.2-0.4)}$ _____
    x Line 1 = ____ workers
                                                           ____   ____

4. In-migrating workers
    with families   = (Line 1 minus sum of
    Lines 2 and 3) = _____ workers
                                                           ____   ____

5. Total in-migrating construction workers (Line 3 plus
    Line 4) = ____ workers (to Step 4)   ____   ____

6. In-migrating spouses (Line 4 x 1.0) =
    _____ spouses (to Step 4)   ____   ____

7. In-migrating children (Line 4 x 1.4)
    = _____ children (to Step 4)   ____   ____

Operation Workers and Dependents
8. Total operations workers = _____
    (from Step 1, Line 1)   ____   ____

9. Local workers = $\overline{(0.4-0.7)}$ $\dfrac{value}{\rule{2em}{0.4pt}}$ x   Line 8
                        range
    = _____ workers   ____   ____

10. Total in-migrating operation workers = (Line 8
    minus Line 9) = _____ workers (to Step 4)   ____   ____

                                range   value
11. In-migrating spouses = $\overline{(0.7-0.8)}$ _____
    x Line 10 = _____ workers (to Step 4)   ____   ____

12. In-migrating children (Line 11 x   1.4)
    = _____ children (to Step 4)   ____   ____

Secondary and Replacement Workers and Dependents

13. Total secondary employment = _____   ____   ____
    (from Step 2, Line 3)

                       range   value
14. Local workers = (0.5-0.7)   _____   x   Line 13
    = _____ workers   ____   ____

15. Construction and operation workers'   range   value
    spouses available for employment =   (0.2-0.4)   ____
    x sum of Lines 6+11) = _____ workers   ____   ____

16. In-migrating secondary workers = Line 13 minus (sum of
    Lines 14+15) = _____ workers   ____   ____

                       range   value
17. Replacement workers = (0.3-0.5)   _____   x (sum of
    Lines 2+9) = _____ workers   ____   ____

18. Total in-migrating secondary and
    replacement workers   = (sum of Lines 16+17)
    = _____ workers   ____   ____

                                      range   value
19. In-migrating single workers = (0.2-0.3)   ____
    x Line 18 = _____ workers   ____   ____

20. In-migrating families = (Line 18 minus Line 19)
    ÷ 1.4 (or your value ____) = _____   ____   ____

21. In-migrating worker households = (sum of Lines 19+20)
    = _____ workers (to Step 4)   ____   ____

22. In-migrating spouses = (Line 20 x 1.0)
    = _____ spouses (to Step 4)   ____   ____

23. In-migrating children = (Line 20   x   1.4)
    = _____ children (to Step 4)   ____   ____

- Constructing a Population Profile of In-migrants   Year _____

Construction Population

1.   Male workers = (value from Step 3, Line 5)   = _____ .

	Age category	Standard value	Your value	x Line 1		
1.a.	20-24	(0.240)	_____	_____	=	_____
1.b.	25-34	(0.406)	_____	_____	=	_____
1.c.	35-44	(0.159)	_____	_____	=	_____
1.d.	45-64	(0.195)	_____	_____	=	_____

2.   Female spouses = (value from Step 3, Line 6)   = _____

	Age category	Standard value	Your value	x Line 2		
2.a.	20-24	(0.240)	_____	_____	=	_____
2.b.	25-34	(0.406)	_____	_____	=	_____
2.c.	35-44	(0.159)	_____	_____	=	_____
2.d.	45-64	(0.195)	_____	_____	=	_____

3.   Children = (value from Step 3, Line 7) = _____

4.   Male children = Line 3 x 0.5 = _____ = Female children

	Age category	Standard value	Your value	x Line 4			
4.a.	< 5	(0.354)	_____	_____	=	_____	Males and females
4.b.	5-11	(0.361)	_____	_____	=	_____	
4.c.	12-14	(0.114)	_____	_____	=	_____	
4.d.	15-17	(0.108)	_____	_____	=	_____	
4.e.	18-19	(0.038)	_____	_____	=	_____	
4.f.	20-24	(0.025)	_____	_____	=	_____	

Operation Population

5.   Operations workers = (value from Step 3, Line 10) = _____

		Standard value	Your value		
5.a.	Male workers = (Line 5 x	0.9 or	_____	) =	_____
5.b.	Female workers = (Line 5 minus Line 5a.) =			_____	

	Age category	Standard value	Your value	x line 5a = Males	x line 5b = Females
5.c.	20-24	(0.196)	_____	x _____ = _____	x _____ = _____
5.d.	25-34	(0.526)	_____	x _____ = _____	x _____ = _____
5.e.	35-44	(0.167)	_____	x _____ = _____	x _____ = _____
5.f.	45-64	(0.111)	_____	x _____ = _____	x _____ = _____

6.   Operations spouses = (value from Step 3, Line 11) = _____

		Standard value	Your value		
6.a.	Male spouses = (Line 6 x	0.1 or	_____	) =	_____
6.b.	Female spouses = (Line 6 minus Line 6.a.) =		_____		

	Age category	Standard value	Your value	x Line 6a = Males	x Line 6b = Females
6.c.	20-24	(0.196)	_____	x _____ = _____	x _____ = _____
6.d.	25-34	(0.526)	_____	x _____ = _____	x _____ = _____
6.e.	35-44	(0.167)	_____	x _____ = _____	x _____ = _____
6.f.	45-64	(0.111)	_____	x _____ = _____	x _____ = _____

7   Male children = (Step 3, Line 12 x 0.5) = _____ = Female children

	Age category	Standard value	Your value	x Line 7		
7.a.	< 5	(0.392)	_____	_____	= _____	Males and females
7.b.	5-11	(0.348)	_____	_____	= _____	
7.c.	12-14	(0.133)	_____	_____	= _____	
7.d.	15-17	(0.095)	_____	_____	= _____	
7.e.	18-19	(0.025)	_____	_____	= _____	
7.f.	20-24	(0.007)	_____	_____	= _____	

Secondary Population

8.   Secondary workers = (value from Step 3, Line 21) = _____

		Standard value	Your value		
8.a.	Male workers = (Line 8 x	0.6 or	_____	) =	_____
8.b.	Female workers = (Line 8 minus Line 8a.) =		_____		

	Age category	Standard value	Your value	x Line 8a = Males	x Line 8b = Females
8.c.	20-24	(0.196)	_____	x _____ = _____	x _____ = _____
8.d.	25-34	(0.526)	_____	x _____ = _____	x _____ = _____
8.e.	35-44	(0.167)	_____	x _____ = _____	x _____ = _____
8.f.	45-64	(0.111)	_____	x _____ = _____	x _____ = _____

9.   Secondary spouses = (value from Step 3, Line 22) = _____

<table>
<tr><td></td><td></td><td>Standard
value</td><td>Your
value</td></tr>
<tr><td>9.a.</td><td>Male spouses = (Line 9 x</td><td>0.4 or</td><td>_____) = _____</td></tr>
<tr><td>9.b.</td><td colspan="3">Female spouses = (Line 9 minus Line 9a.) = _____</td></tr>
</table>

	Age category	Standard value	Your value	x Line 9a = Males	x Line 9b = Females
9.c.	20-24	(0.196)	_____	x _____ = _____	x _____ = _____
9.d.	25-34	(0.526)	_____	x _____ = _____	x _____ = _____
9.e.	35-44	(0.167)	_____	x _____ = _____	x _____ = _____
9.f.	45-64	(0.111)	_____	x _____ = _____	x _____ = _____

10. Male children = (Step 3, Line 23 x 0.5) = _____ = Female children

	Age category	Standard value	Your value	x Line 10	
10.a.	< 5	(0.392)	_____	_____ = _____	Males and females
10.b.	5-11	(0.348)	_____	_____ = _____	
10.c.	12-14	(0.133)	_____	_____ = _____	
10.d.	15-17	(0.095)	_____	_____ = _____	
10.e.	18-19	(0.025)	_____	_____ = _____	
10.f.	20-24	(0.007)	_____	_____ = _____	

Step 4 - Population Summary

Age group	Construction			Operation				Secondary				Total
	Construction workers and spouses (from lines 1 and 2)	Construction children (from line 4)	Subtotal in-migrating construction-related population	Operation workers (from line 5)	Operation spouses (from line 6)	Operation children (from line 7)	Subtotal in-migrating operations-related population	Secondary workers (from line 8)	Secondary spouses (from line 9)	Secondary children (from line 10)	Subtotal in-migrating secondary population	
Males												
< 5	0			0	0			0	0			
5-11	0			0	0			0	0			
12-14	0			0	0			0	0			
15-17	0			0	0			0	0			
18-19												
20-24												
25-34		0				0				0		
35-44		0				0				0		
45-64		0				0				0		
11. Subtotal, males												
Females												
< 5	0			0	0			0	0			
5-11	0			0	0			0	0			
12-14	0			0	0			0	0			
15-17	0			0	0			0	0			
18-19												
20-24												
25-34		0				0				0		
35-44		0				0				0		
45-64		0				0				0		
12. Subtotal, females												
13. Total												

38

Step 5 - Projecting the Residential Location of In-Migrants

    5a. Calculate residential allocation factors for communities of interest

Community	Percent share		
(county or municipality)	Construction population	Operations population	Secondary population
A.			
B.			
C.			

    5b.   Compute residential allocation for each community

Year ____

	Population type			
	Construction	Operations	Secondary	Total
Community (county or municipality)	(1) x (2) = (3)	(1) x (2) = (3)	(1) x (2) = (3)	
A.				
B.				
C.				

(1) = Total population (from Step 4, Line 13)
(2) = Percent share (from Step 5, Line 1)
(3) = Subtotal

    5c. Compute worker allocation for each community

Year ____

	Population type			
	Construction	Operations	Secondary	Total
Community (county or municipality)	(1) x (2) = (3)	(4) x (2) = (3)	(5) x (2) = (3)	
A.				
B.				
C.				

(1) = Total construction workers (from Step 3, Line 5)
(2) = Percent share (from Step 5a)
(3) = Subtotal, or community share
(4) = Total operation workers (from Step 3, Line 10)
(5) = Total secondary workers (from Step 3, Line 21)

<u>5d</u>. Compute community population estimates

Year ____

Community (county or municipality)	Baseline population[a]	+	Project-related population (Step 5b, total)	=	Total population	Increase attributed[b] to project
A.		+		=		
B.		+		=		
C.		+		=		

[a] Assumes ___% growth.

[b] Increase over baseline.

SECTION 3

LAND USE IMPACT ASSESSMENT

GUIDELINES FOR A LAND USE IMPACT ASSESSMENT

The land use impact assessment addresses conversion of habitat to urban or other types of development, and changes in habitat value due to the proximity of urban development. Each is considered a potential land use conflict, and the habitat area where the impact may occur is a potential conflict zone. Where community growth is expected to be a factor, it is necessary to either complete the demographic impact evaluation (Section 2) or obtain access to reliable estimates of community population impacts of a proposed project prior to initiating the land use impact assessment.

The preliminary scoping of conflicts and conflict zones is useful in designing the land use impact assessment. Scoping should be jointly directed by resource managers and local, county, or State planning professionals. If interested members of the public, particularly community leaders from both the public and private sector, can be enlisted in the assessment effort at its very beginning, opportunities for compensation plans or alternative land use development scenarios are greatly enhanced. The closer the spirit and reality of mutual cooperation, the higher the chances of enhancing quality of life considerations for all residents through sound land use policies and responsible decisions by those in charge of local planning.

It is important to convey the fact that impacts on wildlife populations may occur far from the site where habitat loss or degradation is taking place. For example, assume there are two populations of mule deer, one migratory and the other relatively sedentary. The seasonal distribution of these two populations is represented in Figure 1. Each population has 1,000 animals and occupies 110 mi^2 of habitat. For population "A" there is a density of 10 deer/mi^2 on the summer range and during the winter a density of 100 deer/mi^2 on the winter range. For population "B" there is an average density of 9.1 deer/mi^2. Assume a project is proposed that will result in a loss of 1.0 mi^2 due to land use conversions (e.g., a subdivision). If this land is located on the winter range of population "A," it would (theoretically) reduce that population by 100 animals. Though the direct impact would be on the winter range, the land use change would ultimately reduce density 25 mi away, on the summer range, from 10 deer/mi^2 to 9 deer/mi^2. Were the same project to result in loss of habitat within the range of population "B," the loss would be 9.1 deer and this would be felt generally only in the immediate area. Thus, population impacts from the same land use conversion could be 11 times greater on "A" than on "B" and felt over a linear distance

41

MULE DEER
POPULATION "A"

Summer
Range

25 mi

Migration

Winter
Range

MULE DEER
POPULATION "B"

Yearlong
Range

Summer range . . . . . 100 mi^2
Winter range . . . . . 10 mi^2

Population 1,000

Loss of 1 mi^2 ▨ = 100 animals;
impact observed 25 mi from site

Yearlong range . . . . 110 mi^2

Population 1,000

Loss of 1 mi^2 ▨ = 9.1 animals;
impact localized
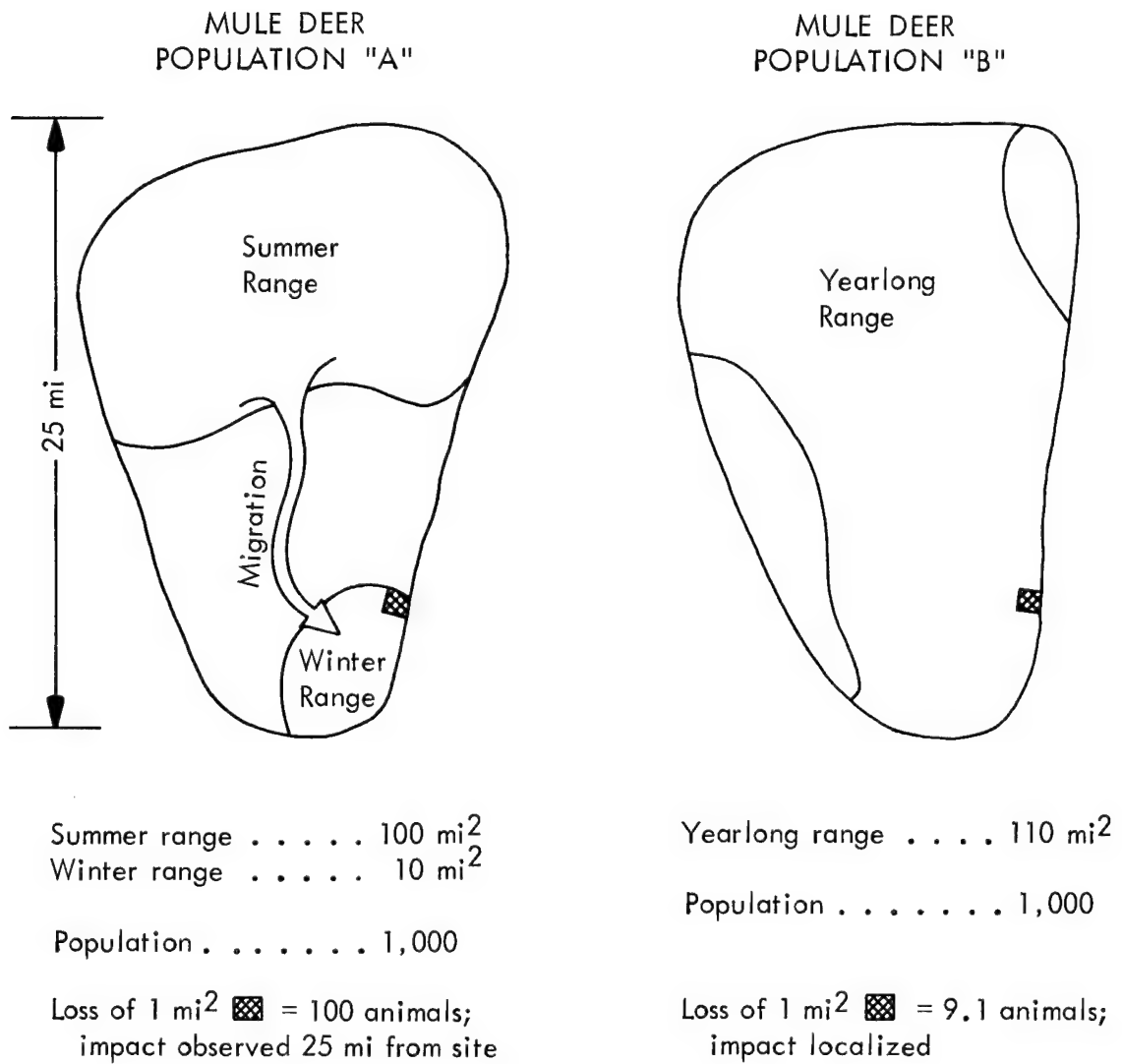
Figure 1.   Illustration of the impacts on animal populations far from
the site of land use conversion.

that is 25 times greater. Of course, this impact might be even
more severe were the migration corridor for population "A" blocked, i.e.,
if the land use conversion occurred in the corridor (Crowe, pers. comm.).

In other words, impact on a species can vary greatly depending upon
the characteristics of the population in question. The potential for damage
is almost always greater for a migratory population than for a sedentary
one. It is therefore important to consider population units when preparing
a land use impact assessment.

INSTRUCTIONS FOR A LAND USE IMPACT ASSESSMENT (WORKSHEET NO. 2)

This procedure addresses land use conversion from habitat to urban land
uses and loss of habitat value through behavioral avoidance due to proximity
of urban development. Conflict zones considered in this section include
those near community growth centers, linear corridors (utility lines, trans-
portation corridors) and satellite developments (airports, recreational homes,
ski resorts, etc.). The assessment uses the following steps:

Step 1 - Setting priorities for land use impact assessment

Step 2 - Identifying habitat in potential conflict with development

Step 3 - Projecting land use conversions for a given target year

Step 4 - Mapping baseline and future "without project" land use
changes in the potential conflict zones

Step 5 - Mapping "with project" land use changes in the potential con-
flict zones

Step 6 - Assessing changes in habitat value in the potential conflict
zones

Representative data and an example Worksheet No. 2 are in Section 11.

Step 1 - Setting Priorities for Land Use Impact Assessment

Form an assessment team and set priorities for wildlife and fisheries
relative to both the impact area and potential land use conversions. The
screening process can be used to identify the most important probable con-
flicts between development and critical or high value habitat. Examples of
priorities for the land use impact assessment might be to minimize conflicts
between development and big game winter range, riparian corridors, and spe-
cial use areas (refuges, breeding or nesting grounds of high interest species,
etc.).

43

<u>Step 2</u> - Identifying Habitat in Potential Conflict with Development

A driving survey is often the easiest approach to identifying priority habitat in potential conflict with land use changes. In addition to obvious conflict zones where known high value habitat exists in the apparent pathway of urban growth, "red flags" can alert resource specialists and planners to other potential conflict zones. Potential red flags are discussed in Appendix C. Categories of urban growth which should be considered and carried through the analysis if appropriate include new or expanded urban growth areas, utility corridors, transportation corridors, airports, and recreational housing developments or recreational use areas. The assessment team should inquire about other potential resource development activity areas as well, such as timber harvest areas and sand and gravel operations. This is an important reason to include interested public and private sector decisionmakers on the team.

Potential conflict zones from urban growth may be identified for one or several communities, for rural county (unincorporated) lands, or for areas near public lands. The decision to complete the land use impact estimation worksheets will depend on the relationship between local fish and wildlife priorities and the potential conflict zones identified.

<u>Step 3</u> - Projecting Land Use Conversions for a Given Target Year

This step is completed for each year for which land use change estimates are desired. This step requires prior completion of Worksheet No. 1 - Demographic Impact Assessment.

Line 1 - Estimate percentage shares for the various types of housing. Standard values shown were derived from surveys of work forces at Western energy projects. The analyst can alter these standard values if the community has plans for housing that would indicate a shift in distribution. Also, excess capacities (e.g., high rental vacancy rates or high vacancy rates for single family residences) may exist for some types of housing. Local planners and energy company officials are important sources of information for finalizing housing preference estimates.

Line 2 - Enter the number of total in-migrating workers, by type, from Worksheet No. 1, Step 3, Lines 5, 10, and 21.

Line 3 - Enter the community share of workers from Worksheet No. 1, Step 5a.

Line 4 - Multiply values in Line 2 by community shares in Line 3 to estimate number of in-migrating workers by community.

Line 5 - Compute the number of housing units, by type, for the community of interest. Multiply distributions (Line 1) by community in-migrating workers (Line 4).

44

Line 6 - Determine land requirements for all urban uses. Standard values in units per acre for various types of housing are included in the worksheet. Alternative values can be used if these are more consistent with what a local area has experienced in the past. The variation for housing density in the worksheet (units per acre = 0.2 to 4) is based on variation between standard subdivisions (4 units per acre) and density in rural county areas (e.g., ranchettes at 0.2 units per acre or otherwise). Local planners are the best source of information; additional guidance on land use standards is given in Appendix D.

Line 7 - Multiply total units column by units per acre (Line 6) to derive total estimated acres required for the various housing types.

Line 8 - Subtotal acres required for housing.

Line 9 - Enter total in-migrants (from Worksheet No. 1, Step 5b).

Line 10 - Calculate number of thousand in-migrants by dividing total in-migrants by 1,000.

Line 11 - Estimate nonhousing and nonstreet land requirements per 1,000 population. The standard value given (38.75 acres per 1,000 population) was based on the land use breakdown given in Appendix D. Alternative values can be used if any of the entries in Table D-2 are inappropriate for the area.

Line 12 - A factor of 1.3 is suggested to account for streets and rights-of-way.

Line 13 - Calculate the subtotal of nonhousing land use requirements.

Lines 14, 15 - Calculate total land use requirements as shown.

Line 16 - Estimate land use requirements for any other developments (e.g., transportation, recreation). Appendix D, Table D-3, includes suggested land use requirements for utilities and roads. Satellite developments (airports, ski resorts) require specific acreage information from city and county planners or developers.

Line 17 - Calculate as shown.

Step 4 - Mapping Baseline and Future "Without Project" Land Use Changes in the Potential Conflict Zones

If there are other energy development projects in the region, communities may experience in-filling and/or expansion in the absence of the projected project's in-migration. For each conflict zone, it is important to develop a baseline and a "without project" land use map for each year of analysis. Local and county planning staff are the best source of assistance in developing such maps.

4a. Baseline map. The baseline map for the community of interest (or corridor route, or rural land where satellite development is projected to occur) should show current developed and undeveloped land uses including urban land use, highways and roads (including unimproved roads), and railroads. Figure 2 shows a hypothetical example. Special natural features (lakes, rivers, creeks, sloughs, mesas, etc) and special use areas (public lands) can be designated; habitat values will be mapped in a later step. Any growth-inducing public facilities (sewage treatment ponds, sewer or water lines, airports, etc.) that are currently satellite developments should also be shown.

4b. "Without project" Map. For each evaluation year a second land use map is needed which shows land use changes projected for the conflict zone. These changes may be reflected in the area's response to previous energy development projects, i.e., past land use trends. Alternatively, the area may be projected to undergo substantial change due to other projects pending construction. Again, area planners and public officials are the best source of future "without project" land use maps. Figure 3 gives an example of future land use without a project.

Step 5 - Mapping "With Project" Land Use Changes in the Potential Conflict
        Zones

The adjustment of projected land uses to account for additional land requirements of the in-migrating population and associated urban development can best be accomplished with assistance from a planning professional familiar with the area. Figure 4 gives a hypothetical example. Land use changes to accommodate urban development are determined by many factors including patterns of land ownership, utility and transportation services and facilities, soil characteristics, and topography.

In the absence of professional planning advice on where the projected conversions are most likely to occur, resource managers can distribute acreages quantified in Step 3 to follow current observed trends. For example, acres for housing can be plotted adjacent to sections of a community where residential land use has occurred or is occurring. Similarly, industrial land use conversions can be plotted as expansions of current or planned industrial use areas.

A map of planned new utility corridors, road development or expansion, or other new developments should also be prepared when such developments have been identified as occurring due to expected population growth associated with the proposed project.

Step 6 - Assessing Changes in Habitat Value in the Potential Conflict Zones

This step requires quantifying habitat values in the areas projected to be impacted by the proposed project. The area of land use change will have been identified by mapping in Step 5. It should represent land development attributable to the proposed project and should be keyed to the year of analysis used for the demographic impact assessment.

46
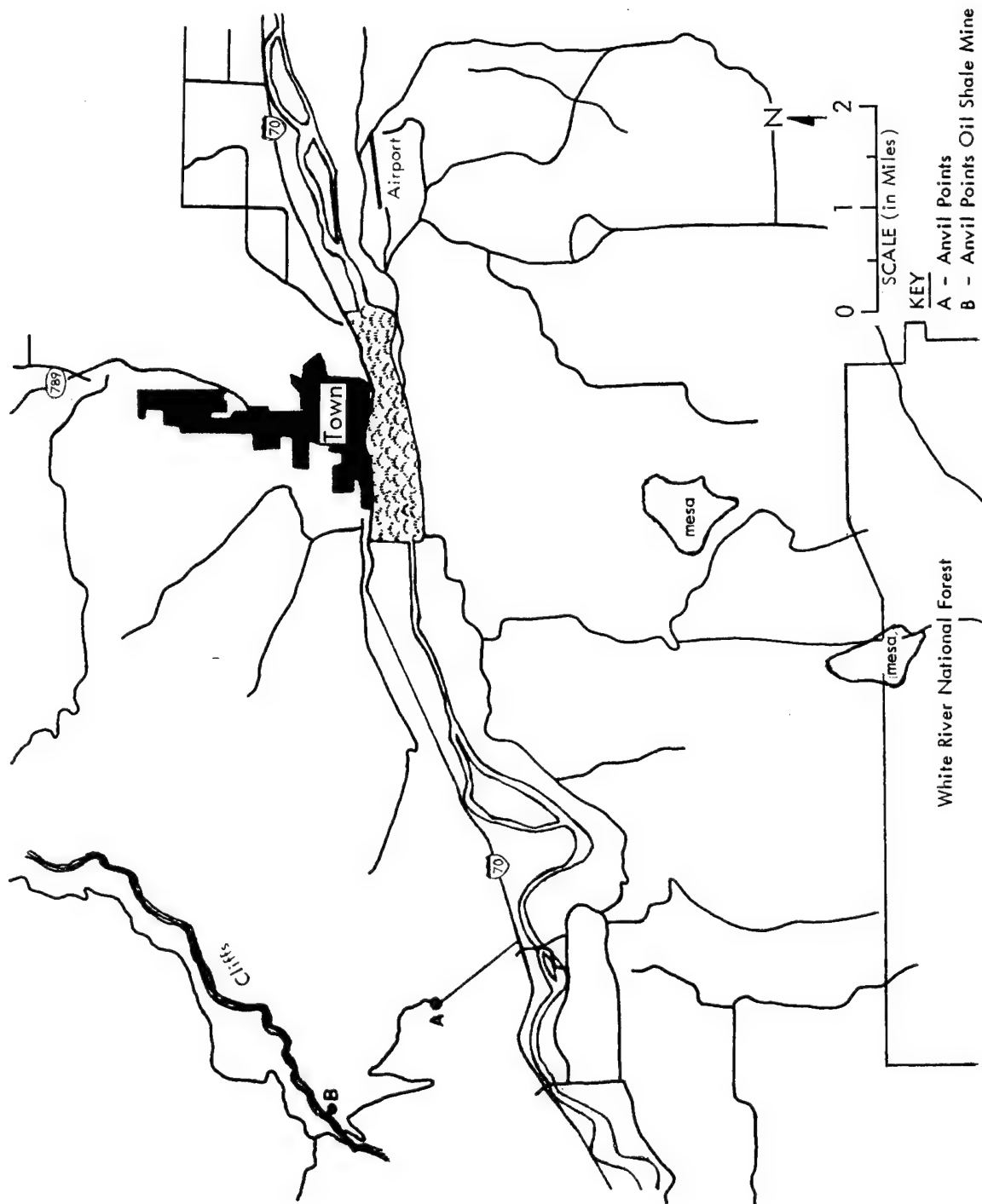
Figure 2. Sample baseline map, including local roads and jeep tracks.
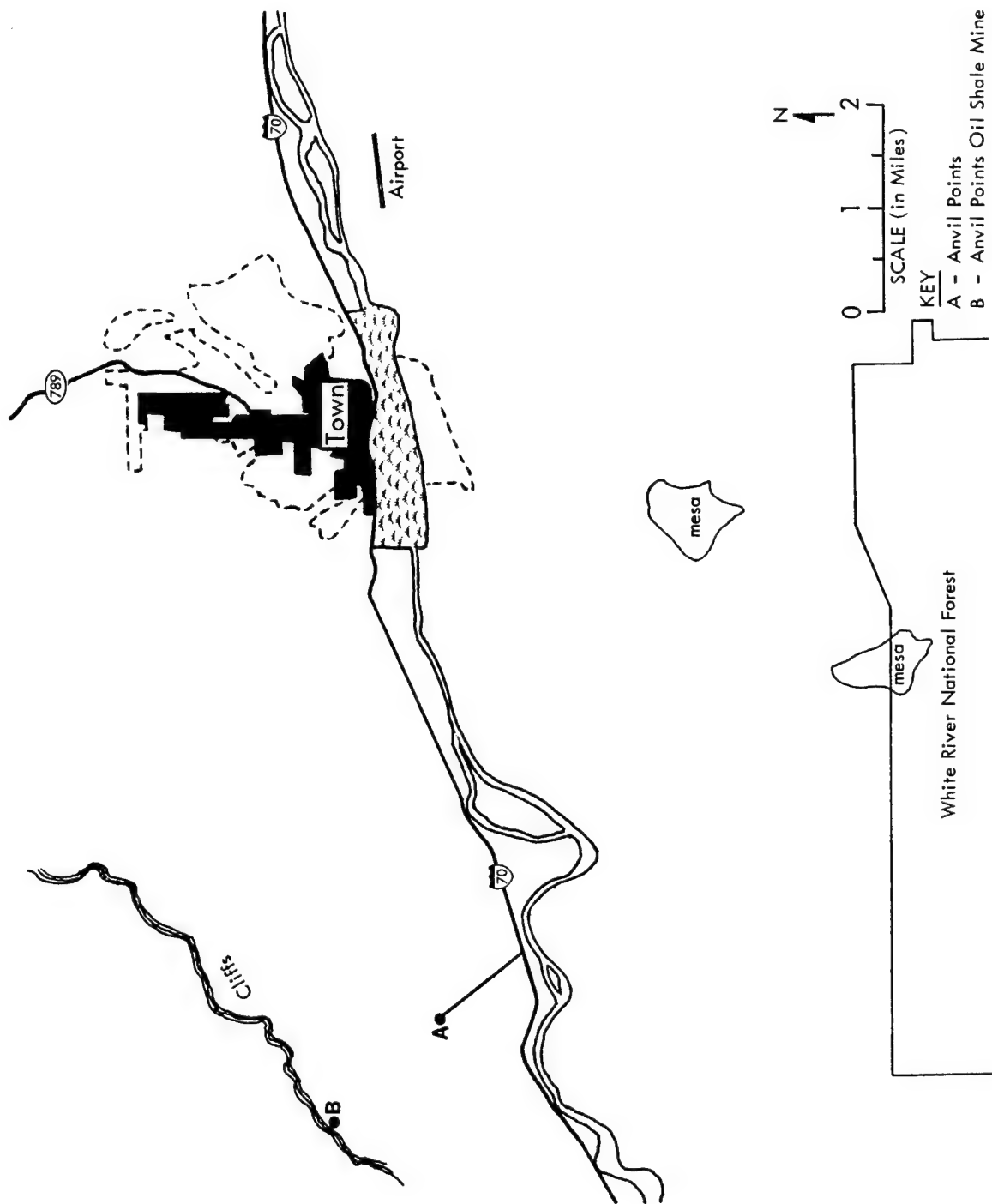
Figure 3.   Sample map showing projected (without project) land use change.

48
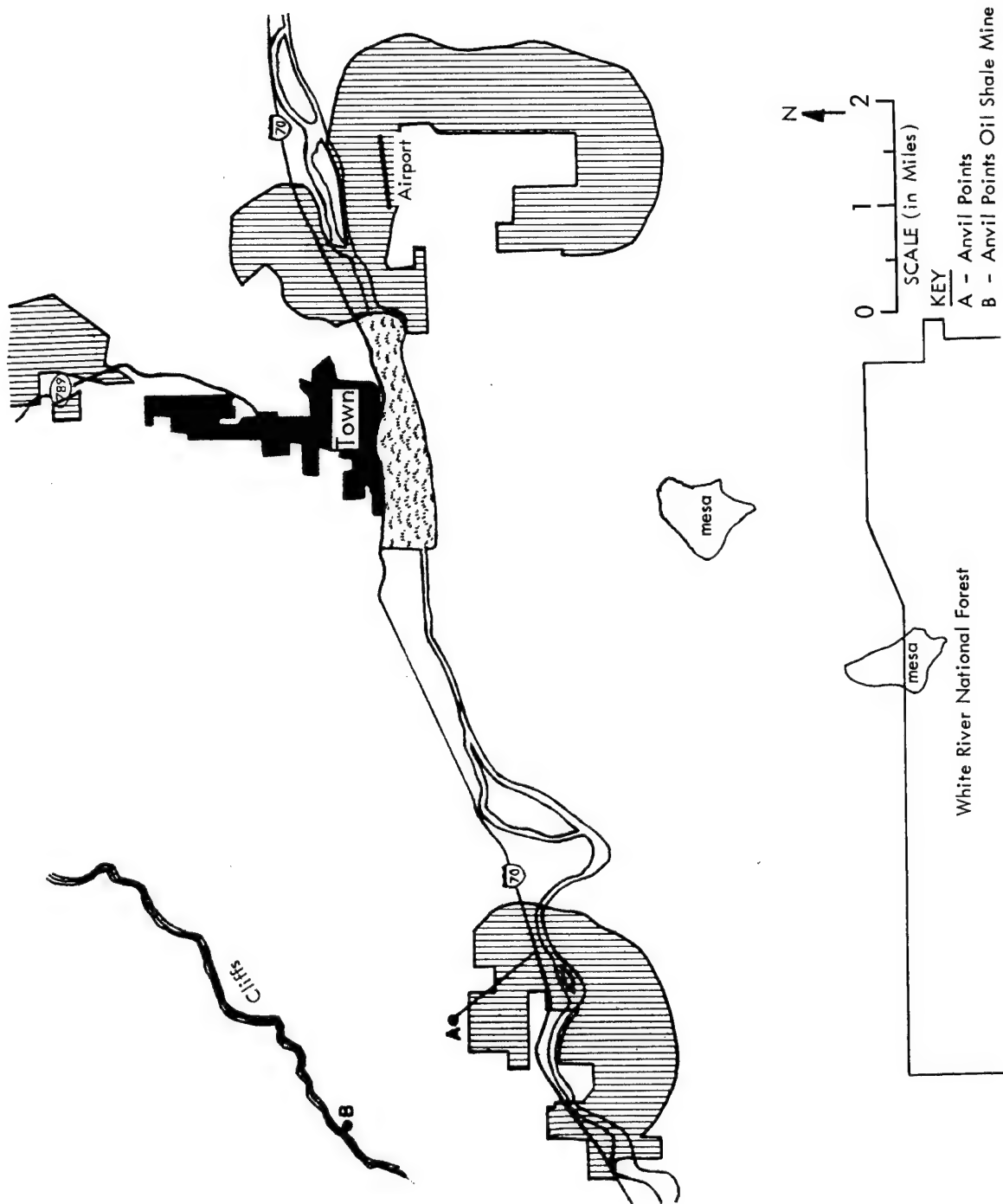
Figure 4. Sample map showing projected land use change attributable to a given project.

Once the land use conversion areas have been identified, a habitat evaluation or similar procedure can be used to estimate change in habitat value due to land use conversions or to general behavioral avoidance near or resulting from development. It should be remembered that direct habitat loss and behavioral avoidance are just two of many ways that habitat value can decline from human demographic impacts. A number of other sources of potential habitat degradation were identified in Section 1.

6a. _Map cover types_. Where large acreages of habitat are projected for conversion to urban use, it is desirable to map at least general cover types in the conflict zone. The cover types selected for delineation in the conflict zones should be relatively homogeneous and highly representative of the areas subject to development or other urbanization influences. Cover type designations should follow a standard system of habitat classification. This system would preferably reflect current systems in use in the State or Federal agencies with responsibility for land management in the study area. There is no single set of cover types that is recommended. Guidance on terrestrial and aquatic cover type classification is available (for example, see U.S. Fish and Wildlife Service 1981). State game and fish agencies should be helpful as well. Cover types can also be mapped to reflect high value use areas. Appendix E gives examples of mapping keys.

The decision as to how much habitat should be mapped will depend on a preliminary consideration of (a) species of interest and (b) quality of protective cover. With the exception of the most sensitive species, such as bighorn sheep or elk, a zone with a radius of approximately 1 mi from all direct habitat conversion areas will capture essentially all the potential behavioral avoidance zone. If the level of human activity is not expected to be high, 0.25 mi can be used as the radius. And if activity is not high and cover quality is very good, 100 yd will suffice for many species.

An alternative to using manual measurements is to use a computer-based mapping system. Whether the effort necessary to employ computer-based mapping is an efficient investment depends on several factors. Foremost is whether the computer input and output are fully compatible with the scale and resolution of map data needed. The mapping programs in the software collection managed by the U.S. Fish and Wildlife Service, Western Energy and Land Use Team, Ft. Collins, CO, can be investigated for their suitability. The next question is whether maps with the applicable environmental features have already been entered into a computer and are usable with no further data entry effort. An additional criterion that determines the feasibility of using computer-based mapping concerns the extent to which the maps will be used. If more than one analysis will be done on a given area, such as management planning on public land, then a computer-based mapping effort may be quite cost effective.

If small areas are being considered, there may be no reason to map cover type. Or, if habitat productivity (e.g., animal densities) for the evaluation species is not available or cannot be calculated other than in aggregate area estimates, it will be necessary to overlook separate cover types and generalize about habitat in the conflict zone.

6b. Select evaluation species. Cover maps and area baseline informa-
tion will aid in selecting evaluation species. Appendix E provides brief
guidance from the U.S. Fish and Wildlife Service on the selection of evalu-
ation species for habitat evaluation procedures. Evaluations can also be
based on community guilds. It is important to consider whether or not im-
pacts will affect wildlife populations (e.g., herd units) far from the site
where development actually occurs. Planners, government officials, and the
private sector should be given information that reflects any off-site im-
pacts.

6c. Determine habitat in conflict zone and habitat value loss for each
evaluation species. Two categories of area in the conflict zone need to be
recognized: habitat to be converted to nonhabitat use (complete habitat
loss) and habitat to be reduced in value due to behavioral avoidance (or
other environmental factor known to the analyst). The location of habitat
converted to nonhabitat use and the extent of this conversion will have
been identified in Step 5. The location of habitat with reduced value and
the extent of this loss in value needs to be identified in this step.

At this point the analyst should consider snowmobile use areas and off-
road vehicle (ORV) use areas in potential conflict with habitat areas. Sec-
tion 4 provides guidance on identifying these areas. They should be included
as conflict zones if identified as having significant increases in use due
to the in-migrating population.

Some guidance on delineating behavioral avoidance zones is provided in
Table 5. These sample zones should be refined by resource managers familiar
with the area and the evaluation species.

Sample maps are included to show impacts on bighorn sheep (due to a
behavioral avoidance zone--see Figure 5), mule deer (direct loss of criti-
cal winter range and high value winter range at two sites and conflict with
snowmobile use on critical winter range at a third site--see Figure 6), ri-
parian habitat (direct loss of wetland and riparian areas critical for num-
erous small game and aquatic life--see Figure 7), and sage grouse (habitat
degradation on strutting areas in conflict with ORV use areas--see Figure 8).

The resource manager will need to make an estimate of the percentage
loss of habitat value in the zone for the evaluation species. Conversion
areas will have a 100 percent loss. In behavioral avoidance zones it is
expected that between 50 and 100 percent of habitat value will be lost.
For example, the extent to which animals feel they have an available escape
route will affect their willingness to use areas normally considered behavi-
oral avoidance zones.

6d. Determine acreage by cover type in the conflict zone. Where con-
flict zones are large and heterogeneous, it is recommended that acreage by
cover type be estimated for the conflict zone.

6e. Estimate the future change in productivity in the conflict zone.
For each evaluation species, a simple calculation of area times density
times percentage loss in habitat value will yield an estimate of loss in
productivity.

51

Table 5. Sample behavioral avoidance zones for wildlife near urban development (numbers in yards in all directions from source of disturbance)

| | Low to medium activity use[a] | | | Medium to high activity use[b] | | |
| | Cover quality | | | Cover quality | | |
	High (1)	Medium (2)	Low (3)	High (4)	Medium (5)	Low (6)
Big game						
Pronghorn	100	200	300	450	600	1,000
Deer	50	200	300	450	600	1,000
Elk	100	500	800	1,200	1,500	3,600
Bighorn sheep	100	400	800	1,300	1,700	3,600
Mountain lion	100	1,400	1,400	1,500	1,500	1,500
Black bear	100	500	800	1,200	1,500	1,500
Upland game						
Sage grouse	50	500	500	600	600	1,300
Sharptail grouse	50	500	600	700	800	1,800
Small game						
Cottontail	30	50	70	90	100	100
Furbearers						
Bobcat	1,800	1,800	1,800	1,800	1,800	1,800
Waterfowl	50	200	300	400	500	500
Raptors						
Eagle, falcon	600	800	900	1,000	1,100	1,800
Red-tailed hawk	100	400	500	500	500	600

Source: Midwest Research Institute.

Explanation: Data were generated based on conversations with wildlife resource professionals in Colorado, Wyoming, and Montana. Numbers are estimates only. Values for columns 1 and 6 were the extreme ranges; values for columns 2 and 5 were the averages for low and high visibility areas; values for columns 3 and 4 were extrapolations between 2 and 5. Where a road is under evaluation, the avoidance zone is on each side. Topography as well as cover is a factor. This factor should be included with cover when estimating quality.

[a] Examples: residential land use, low activity public use, occasional travel on unimproved roads, recreational develement with weekend use primarily, snowmobile or ORV area with under 20 users per week.

[b] Examples: commercial or industrial land use, regular use of public buildings, recreational development with active sports on weekday basis, snowmobile or ORV area with over 20 users per week.

52
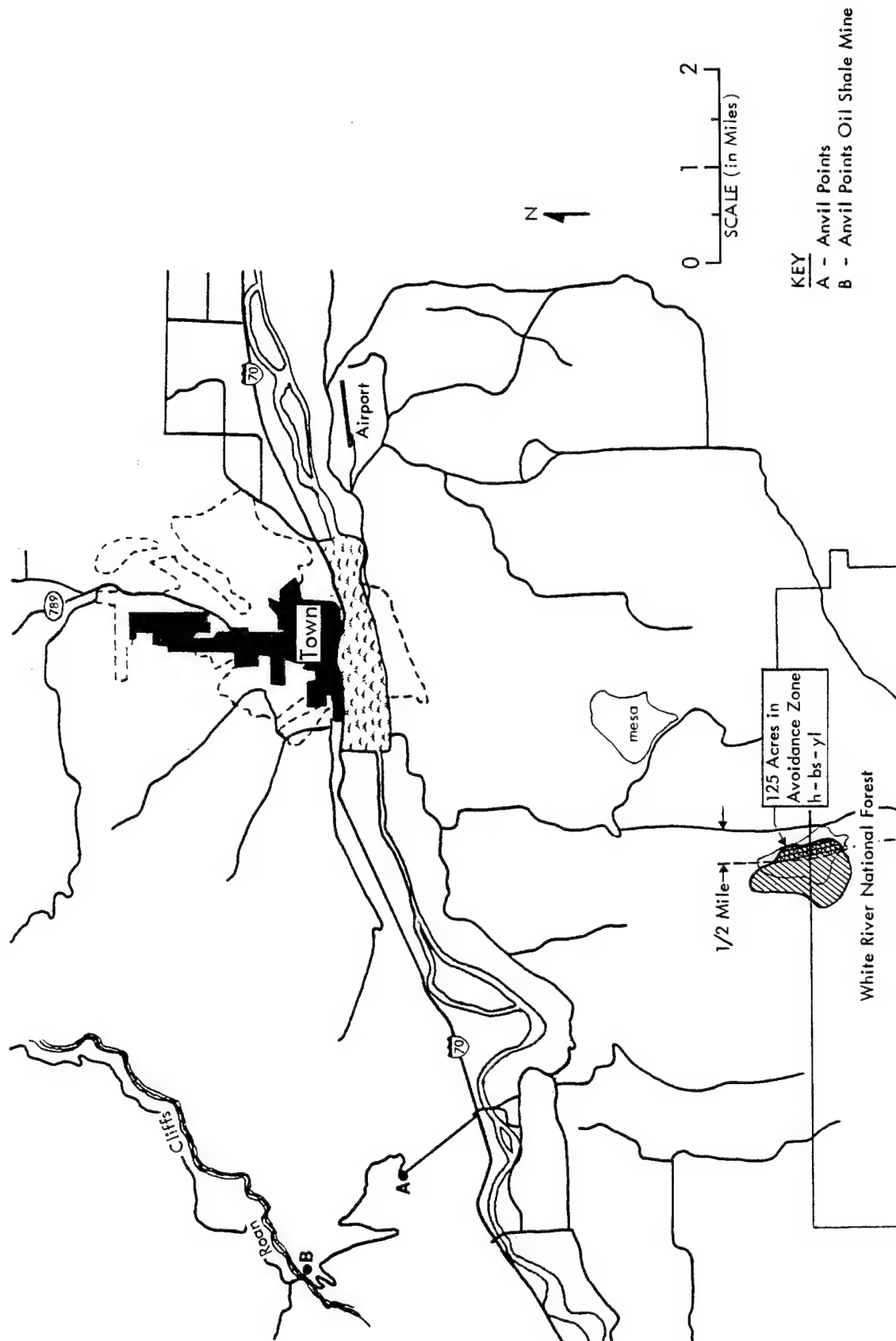
Figure 5. Overlay map of bighorn sheep (bs) avoidance zone in high value (h) year-long (yl) range.

KEY
A - Anvil Points
B - Anvil Points Oil Shale Mine

SCALE (in Miles)
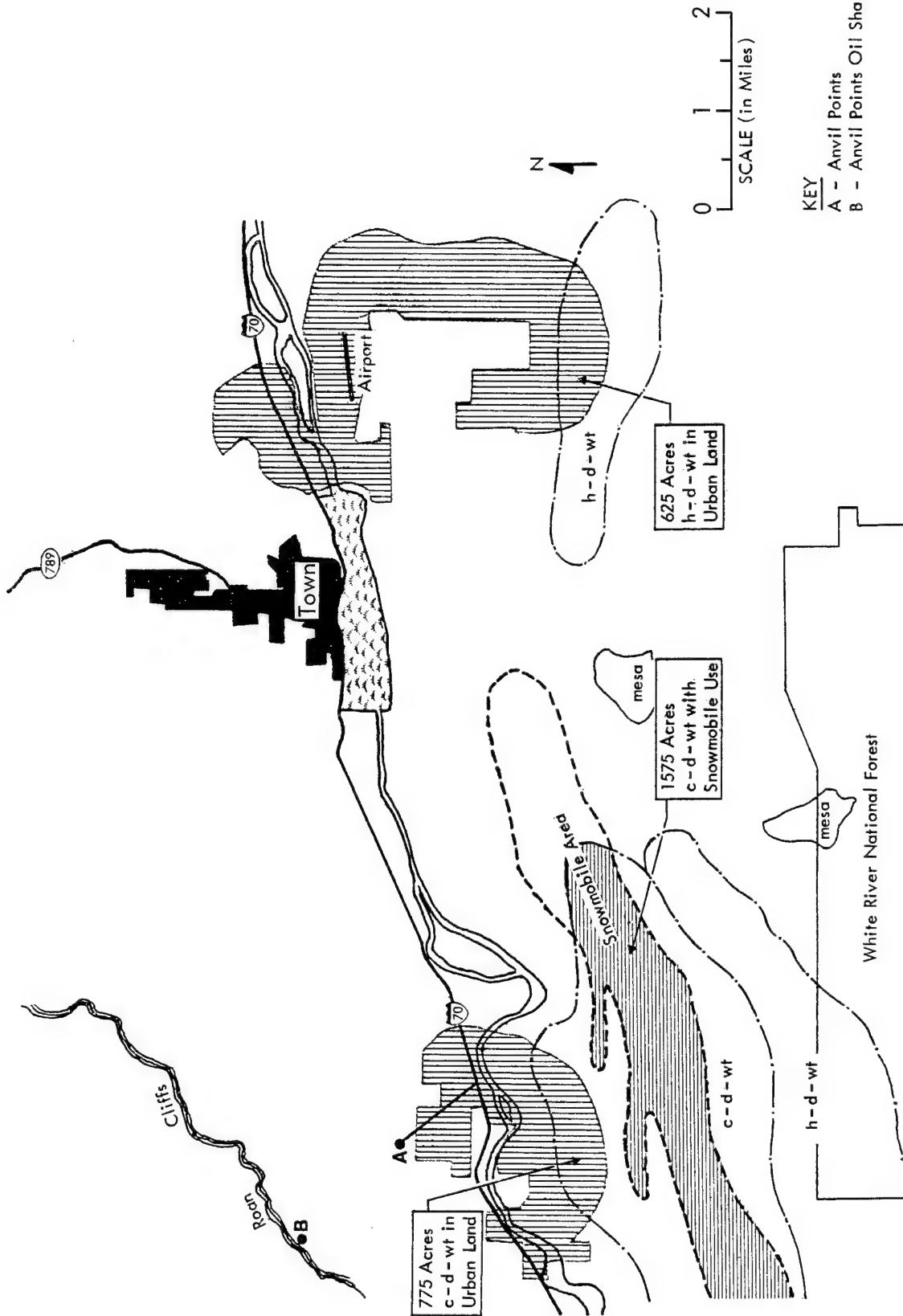
Figure 6. Overlay map of mule deer (d), critical (c), and high value (h) winter (wt) range.

625 Acres
h–d–wt in
Urban Land

1575 Acres
c–d–wt with
Snowmobile Use

775 Acres
c–d–wt in
Urban Land

h–d–wt

c–d–wt

h–d–wt

Town

Airport

Snowmobile Area

White River National Forest

mesa

mesa

Cliffs

Roan

A

B

SCALE (in Miles)

0   1   2

N

KEY
A – Anvil Points
B – Anvil Points Oil Shale Mines
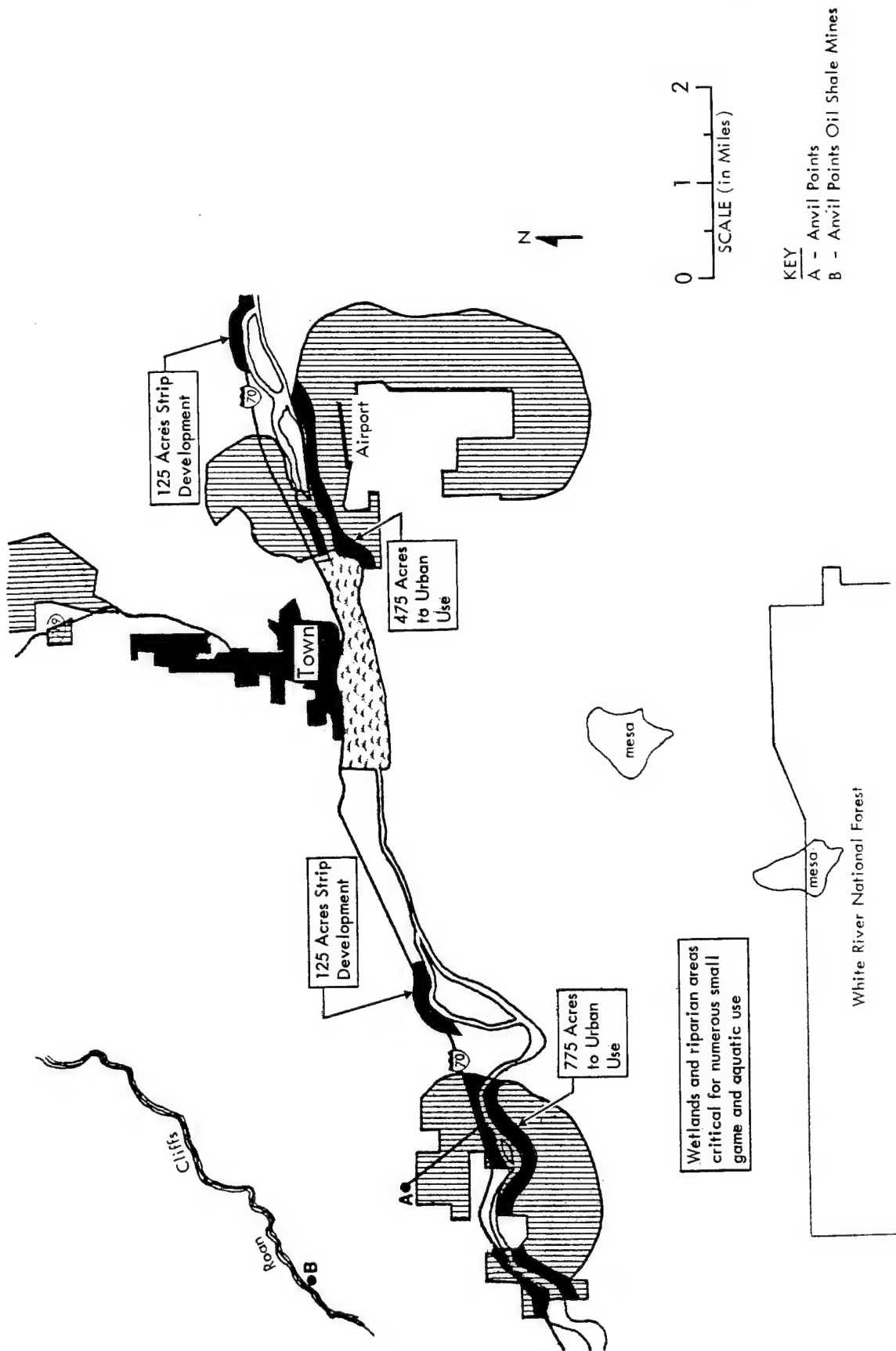
Figure 7. Overlay map of urabn development in conflict with riparian areas.

KEY
A - Anvil Points
B - Anvil Points Oil Shale Mines

SCALE (in Miles)
0   1   2

N

125 Acres Strip Development

475 Acres to Urban Use

Airport

Town

125 Acres Strip Development

775 Acres to Urban Use

Wetlands and riparian areas critical for numerous small game and aquatic use

White River National Forest

mesa

mesa

Cliffs

Roan

A

B
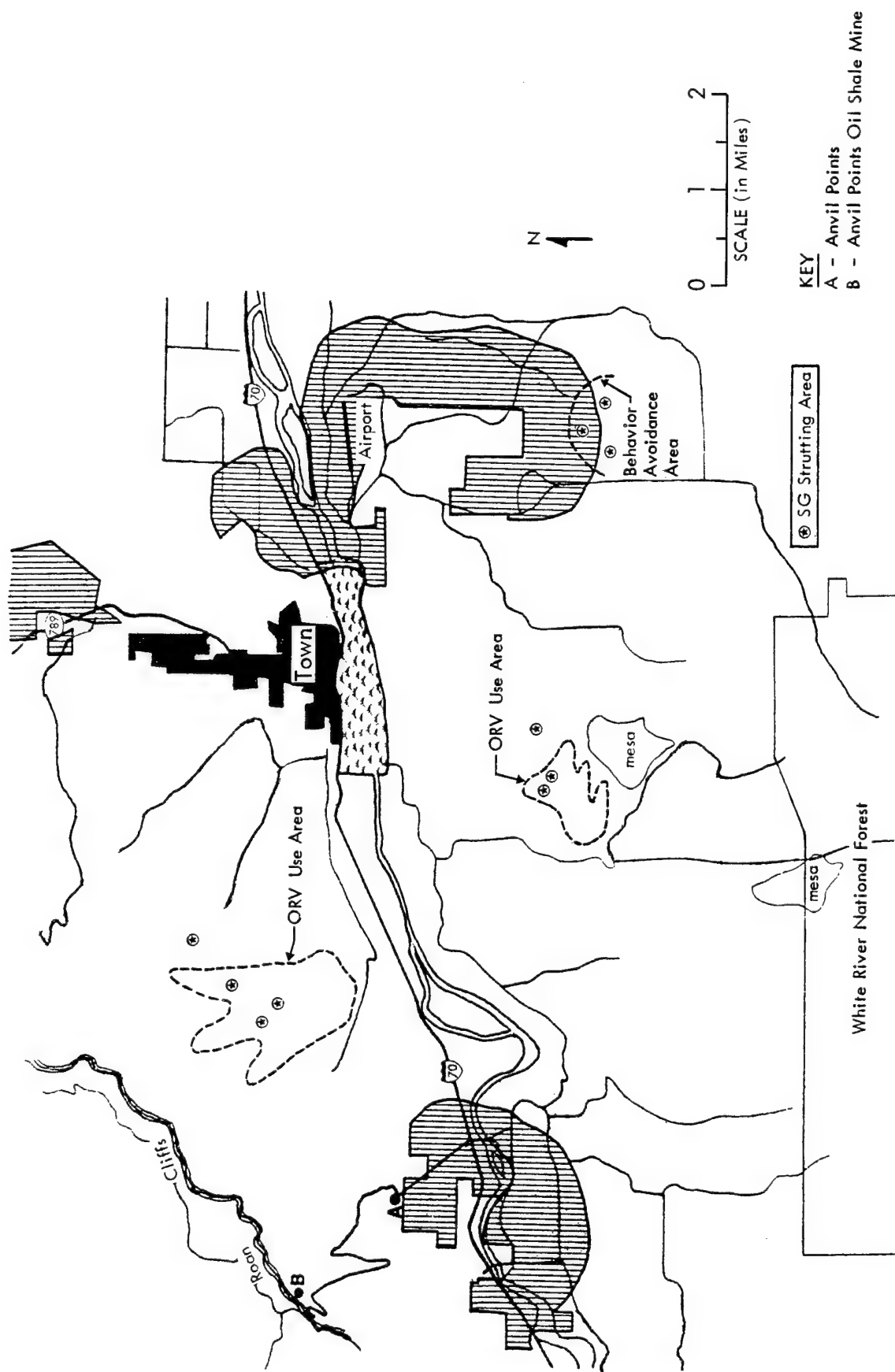
Figure 8. Overlay map of sage grouse strutting areas in conflict with ORV use areas and urban development.

KEY
A – Anvil Points
B – Anvil Points Oil Shale Mine

⊛ SG Strutting Area

SCALE (in Miles)
0   1   2

N

Cliffs

Roan

●B

ORV Use Area

Town

Airport

ORV Use Area

mesa

mesa

Behavior
Avoidance
Area

White River National Forest

Worksheet No. 2

LAND USE IMPACT ASSESSMENT

Step 1 - Setting Priorities for Land Use Impact Assessment

    a.

    b.

    c.

    etc.

Step 2 - Identifying Habitat in Potential Conflict with Development

                                                                     Yes   No

a.   Around communities or community spheres of influence: ___ ___

       If yes, list communities of primary concern: _____

    _____

                                                          Yes   No

b.   Along proposed developments (highway, railway, power line, ___ ___
    or other corridors)

    If yes, list developments of concern:

    _____

    _____

                                   Yes   No

c.   On rural county or public lands: ___ ___
       If yes, list counties and locations of concern: _____

    _____

    _____

Step 3 - Projecting Land Use Conversions for a Given Target Year

Community: _____ Year _____

	Construction workers		Operation workers		Secondary workers	
1. Type of housing:	Standard values	Your values	Standard values	Your values	Standard values	Your values
Single family house	15%	___	60%	___	40%	___
Apartment	10	___	20	___	33	___
Mobile homes	60	___	20	___	27 ·	___
Other·(e.g., motels, RVs, mancamps, and sleeping rooms, etc.)	15	___	0	___	0	___
Total	100%	___	100%	___	100%	___

	Construction workers	Operation workers	Secondary workers
2. Total in-migrating workers (from Worksheet 1, Step 3)	___ (line 5)	___ (line 10)	___ (line 21)
3. Community share (from Worksheet 1, Step 5a)	x ___	x ___	x ___
4. Number of worker households	= ___	= ___	= ___

58

Community: _____   Year _____

	Construction workers			Operation workers			Secondary workers			5. Total housing
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	
House	__ x	__ =	__	__ x	__ =	__	__ x	__ =	__	____
Apartment	__ x	__ =	__	__ x	__ =	__	__ x	__ =	__	____
Mobile home	__ x	__ =	__	__ x	__ =	__	__ x	__ =	__	____
Other	__ x	__ =	__	__ x	__ =	__	__ x	__ =	__	____
5. Total housing	__ x	__ =	__	__ x	__ =	__	__ x	__ =	__	____

(a) = Percent by unit type, line 1
(b) = Number of worker households, line 4
(c) = Units

	Total units (from line 5)		6. Units per acre		7. Acres
Houses	_____	÷	range (0.2-4) _____	=	_____
Apartments	_____	÷	range (8-15) _____	=	_____
Mobile Homes	_____	÷	range (8-15) _____	=	_____
Other Units	_____	÷	range (15-20) _____	=	_____
8. Subtotal					_____

Land requirements for other urban uses

9.   Total in-migrants (from Worksheet No. 1, Step 5b)   = _____

                                                    ÷ 1000

10.   = _____

       Acres per 1,000 new population, other urban uses   x   38.75

11.   Acres, excluding housing, streets, and   = _____
       rights-of-way

                                                        x   1.3

12.   Acres for streets and rights-of-way   = _____

13.   Subtotal, acres for all nonhousing uses   = _____
       (Lines 11 + 12)

14.   Housing acres (subtotal, Line 8)   + _____

15.   Total acres, housing and community development   = _____

16.   Compute any other land use conversions

                                                          Year: ____

(Location)	(standard)	(acres)	(notes)
Utility _____)	_____	_____	_____
Roads _____)	_____	_____	_____
Satellite developments:		_____	
_____		_____	_____
_____		_____	

                                        Subtotal = _____

17.   Total acres, all conversions
       (Lines 15 plus 16)   = _____

Step 4 - Mapping Baseline and Future "Without Project" Land Use Changes in
          the Potential Conflict Zones

Of primary interest is community development into high value habitat or other high priority areas identified in Step 1. The baseline map should include, at a minimum, city limits, types of land use nearest potential conflict areas, roads (including unimproved roads), and waterways. Linear developments that are expected to develop even in the absence of the proposed project, as well as satellite developments, should also be mapped as appropriate.

Step 5 - Mapping "With Project" Land Use Changes in the Potential Conflict
          Zones

Distribute land use conversion projections (computed in Step 3) to communities, corridors, or rural areas. Confirm projections in consultation with local planners or county officials.

Step 6 - Assessing Changes in Habitat Value in the Potential Conflict Zones

Map, quantify, and total habitat losses due to direct conversion and/or behavioral avoidance zones.

SECTION 4

HUNTING, FISHING, AND OTHER WILDLIFE-RELATED
RECREATION IMPACT ASSESSMENTS

GUIDELINES FOR A HUNTING IMPACT ASSESSMENT

Because hunting (and fishing) harvests are relatively easy to regulate (by season length, number of permits, bag or creel limits, etc.), the increased demand for these recreational activities that accompanies in-migration to an area theoretically has less of an impact on the wildlife resource than on the quality of the experience for those participating. The fact that hunting opportunity and hunter success will decline as the number of hunters increases is an impact seldom addressed when considering the needs for recreational facilities and services which in-migrants bring with them as they settle in an area. There are as yet no accepted standards by which to assess the relative quality of hunting experiences under different degrees of crowding, and no threshold values for numbers of hunters per area above which the quality of the hunting experience can be shown to always decline.

The procedure in this section is aimed at quantifying additional demand for hunting in order that the analyst can estimate changes in hunting opportunity (where lottery or limited permits are already in use). It is also assumed that data on additional demand for hunting could, at some point, be translated into recommendations for methods to increase carrying capacities through habitat enhancement and in this way provide additional supplies of wildlife to meet demand.

It is important to have a good idea at the outset of the assessment of what hunting participation data are available for an area. The primary sources of data are State game and fish departments, National surveys (U.S. Department of the Interior and U.S. Department of Commerce 1982), and State outdoor recreation plans. A last resort is to collect primary data through surveys; this is very often too expensive and time consuming to be practical, however.

Game and fish department data on the numbers of licenses bought by license type should be readily available. Age and sex breakdowns of license buyers may or may not be available, however. These data as well as the residence of licensees are most often available when license lotteries are held. State game and fish departments may also have data on hunting activity collected through hunter surveys. State game and fish departments generally collect data at the game management unit level. These units coincide with

natural boundaries (river basins, mountain slopes, etc.) rather than political boundaries (e.g., counties). Hunter activity data (harvest, days hunted, etc.) are used to manage game within game management units. License sales or the number of participants may often be available at the county level, since licenses are dispersed through a central vendor.

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior and U.S. Department of Commerce 1982) is published every 5 years, and State surveys are also available. These surveys provide data on hunting and fishing activities including age and sex distribution of participants, expenditures, and number of days of participation. These State surveys are the most readily available source documents that provide a consistent and uniform data format for all States.

State comprehensive outdoor recreation plans (SCORPs) may also provide information on resident hunting activities. SCORPs have typically been published every 5 years, but lack the state-to-state consistency of the national survey data.

Other sources include surveys of hunting activity conducted by universities, sports clubs, local chambers of commerce, or other organizations. This type of survey may be difficult to locate but can provide area-specific data that are otherwise hard to obtain.

Participation rates for the in-migrants to the area are needed to generate estimates of demand for the various hunting categories. These data may become available in the future as research on rapid growth areas and characteristics of energy development work forces continues. For the present procedure, however, it is assumed that no direct estimates of such participation are available, and the analyst will need to use standard participation rates developed for the local impact area's resident population.

Data by county or other impact area may not be readily available or may take considerable effort to develop. A review of license stubs or computerized lists of license applicants may provide county-level data. The use of the national survey is encouraged where other data are not available on participation rates.

Worksheet No. 3 - Hunting Impact Assessment uses the same age groups as those used in the demographic impact assessment procedure. The worksheet assumes that participation rates of local, county, or State residents can be obtained or derived, generally through the help of State game and fish personnel. In the event that no such data on current areas are available or time does not permit their preparation, the analyst can use the national survey for participation rate. Other standards may use different age categories, and it will be necessary to adjust the population profile of the in-migrants to reflect the profile structure of the national data. Table B-6 in Appendix B gives a supplemental picture of the age distribution of the in-migrating work force and dependents. Using this table the analyst can reconstruct a population profile for in-migrants using age categories consistent with available participation rate standards.

INSTRUCTIONS FOR A HUNTING IMPACT ASSESSMENT (WORKSHEET NO. 3)

The following steps will provide local resource managers and decision-makers with estimates of the changes in demand for hunting attributable to new in-migration in energy impact areas:

Step 1 - Identifying and categorizing local hunting opportunities

Step 2 - Developing a profile of current resident licensees

Step 3 - Applying participation ratios

Step 4 - Summarizing net impacts and estimating the effect of in-migrant license demand on the chances of obtaining a restricted license

Representative data and an example Worksheet No. 3 are found in Section 11.

Step 1 - Identifying and Categorizing Local Hunting Opportunities

By grouping hunting activities in general categories that coincide with either license or activity data, calculations of recreation demand are simplified. Species of interest should be identified. Further, division into either restricted or unrestricted license types is important. Restricted licenses are those that are issued by lottery to a limited number of applicants, while unrestricted licenses are generally available over the counter. The following general hunting categories are suggested for Step 1.

Line 1 - Big Game:
The availability of big game licenses is often restricted, with licensees being selected through lottery. The common big game species are white-tailed and mule deer, pronghorn, elk, and black bear. Other species may include moose, bighorn sheep, mountain goat, and mountain lion.

Line 2 - Upland Game/Small Game:
Small game licenses are usually available to residents over the counter in unlimited numbers. Upland game birds of concern in many energy impact areas include sharp-tailed grouse, ring-necked pheasant, sage grouse, turkey, Hungarian partridge, blue grouse, mourning dove, chukar partridge, and ptarmigan grouse. Upland game mammals may include rabbit, hare, and squirrel.

Line 3 - Waterfowl (Migratory Birds):
Waterfowl hunting is generally allowed with the small game license. However, some States require separate waterfowl stamps or permits. While these are not restricted to resident hunters, many States restrict the number of nonresident waterfowl permits issued. Ducks and geese constitute the majority of waterfowl harvested. Hunting migratory waterfowl requires a special stamp issued by the Federal government in addition to some sort of State license.

Line 4 - Furbearers/Predators:
The small game license often allows hunting of predators or fur-bearers, while some States require an additional license. Special licenses to trap may be required. Predators or furbearers include coyote, fox, raccoon, lynx, bobcat, and badger.

Step 2 - Developing a Profile of Current Resident Licensees

It will usually be necessary to assume that in-migrants will participate in hunting activities in the same proportions and participation levels as current residents. Therefore, participation rates for current residents are needed.

Line 1 - Impact Area Selection:
Depending on data availability, a choice must be made between using or developing county, game management unit, or state-level data. State and game management unit-level data are generally more readily available than county-level data.

Line 2 - License Type Selection:
Step 2 should be repeated for each type of license or category of hunting. For instance, a separate calculation would be required for big game, upland game, waterfowl, and furbearers/predators if those categories are used. However, if individual species data are used, then Step 2 would be required for each species. The number of repetitions required depends on the available data and desired detail.

Line 3 - Data by License or Activity:
Data compiled by license type or activity type will again be dictated by available data. License data would consist of hunter characteristics by license type. This is not a problem when only one species can be hunted with a specific license; it becomes problematic when many species can be hunted with a single license. Most big game licenses allocated through lottery are for single species, in which case there would be no difference between license type or activity data. There is a considerable difference, however, among the types of activities available with a small game license. In this instance, license data might aggregate activities from goose hunting to dove hunting, two very different hunting experiences. Data availability and diversity of hunting opportunities within an impact area will help to determine the most appropriate direction to take.

Line 4 - Participation Ratios:
The demographic impact estimation worksheet (Worksheet No. 1) contains a method to generate in-migrant profiles by age and sex categories. The age groups used are those repeated here. It is desirable to maintain these disaggregated categories if possible since the in-migrant population contains a disproportionately high number of males in the high participation 20- and 30-yr age groups. And

65

while hunting participation rates are often presented as a percentage of the overall population, the national survey indicated that 92 percent of all hunters are male. Since resident population structure is considerably different from the in-migrant population structure, particularly during the construction phase, attention must be paid to the influence that age and sex distribution has on potential hunting participation.

Step 3 - Applying Participation Ratios

Line 1 - Enter disaggregated age groups from Step 2.

Line 2 - Enter number of in-migrants by age group from Worksheet No. 1, Step 4. If it is necessary to compile in-migrant population estimates under different age group categories, refer to Appendix B, Table B-6.

Line 3 - Enter ratios derived from Step 2.

Line 4 - Multiply Line 2 by Line 3 entries to obtain number of new participants or applicants for the license or activity type under assessment. (It is assumed that nonparticipants make up a very small percentage of licensees; an estimated 2 to 3 percent of the lottery type licensees are nonparticipants while 5 to 10 percent of over-the-counter licensees do not participate. In the absence of specific data for a given area, this source of variability will be ignored.)

Line 5 - After totaling the number of new participants or licensees, enter an estimate of days per licensee for that activity. Average days per participant per activity or license type are available from several of the sources mentioned previously. State fish and game agencies are the preferred source.

Line 6 - Multiply total licensees by the Line 5 entry to estimate total potential demand from in-migrants for the activity.

Step 4 - Summarizing Net Impacts and Estimating the Effect of In-Migrant License Demand on the Chances of Obtaining a Restricted License

Step 4 is designed to summarize data on additional demand by hunting category or species. Also included is a brief checklist of other considerations which may be viewed as probable adverse spin-off effects of increased demand. The user may wish to highlight other impacts as well. These other considerations will be dependent upon local impact area conditions.

Land availability or access is important in the use of private lands by hunters. Increased numbers of hunters may result in increased posting of private lands, a factor of considerable concern to resource managers.

Crowding on public lands may also cause the quality of the hunting experience to deteriorate and result in either lower hunter satisfaction or reduced participation by original local residents. More hunters competing for the chance to draw a big game permit must be considered. More hunters reduce the chance for every other hunter to be drawn. Finally, the procedure outlined merely shows how demand will change. Changes in supply must be brought about through game and fish management policy. If increased demand exceeds supplies, land and wildlife may need to be managed to produce more opportunities and shorter seasons, or lower bag limits may be necessary. Supply estimation procedures are not provided. It was the consensus of fish and game professionals that supply estimation is a procedure already required by State and Federal field biologists, especially where on-site mining impact are to be evaluated. The FWS Human Use and Economic Evaluation procedures (104 EMS) can be used to evaluate supply and demand, taking account of changing supplies and demands in future years. In addition, the 104 EMS procedures may be used to develop comparisons of supply and demand between years for which data are estimated (U.S. Fish and Wildlife Service 1980b).

Additional demand for those types of hunting wherein the number of licenses is restricted will be reflected in reduced odds for obtaining a license through a lottery. Step 4 includes the procedure to estimate the change in lottery success due to additional applicants. The net change in local hunting pressure depends on assumptions made about where in-migrants are from. If they come from areas near the impact area, they may return to their former home area to hunt. If they come from within the State, they will not affect big game lotteries as much as if they are newcomers to the State.

As a final note, estimates can vary widely depending on aggregation/disaggregation of input data and input data source. A suggested procedure is to develop both high and low projections using the appropriate mix of data. This will produce a range of outcomes rather than a single point estimate.

Worksheet No. 3

HUNTING IMPACT ASSESSMENT

Step 1 - Identifying and Categorizing Local Hunting Opportunities

County/Area_____

	Species	License/license availability
1. Big game		
2. Upland game/small game		
	All others	
3. Waterfowl	Ducks & geese	
	All others	
4. Furbearers/predators		
	All others	

Step 2 - Developing a Profile of Current Resident Licensees

1. Impact area _____

2. License type _____

3. Data by: license or activity _____

4. Participation ratios:

Age group[a]	Current area population[b]	Number of licensees or applicants	Participation ratio	Notes[c]
(example):				

Males

< 12				
12-14				
15-17				
18-19				
20-24				
25-34				
35-44				
45-64				
> 64				

Females

(examples):				
< 12				
12-14				
15-17				
18-19				
20-24				
25-34				
35-44				
45-64				
> 64				

---

[a] Do not aggregate ages until completion of Step 3.
[b] From census data or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.
[c] Include participation ratios from other sources.

Data Source(s) _____

_____

Step 3 - Applying Participation Ratios

Impact area _____

License or activity type _____

Year _____

List in-migrants by age/sex category using data from demographic profiles.

1. Age group (example):	2. Number of in-migrants	3. Participation ratio (Step 2)	4. Potential new participants or applicants	Notes

Males

< 12

12-14

15-17

18-19

20-24

25-34

35-44

45-64

> 64

Females

(example):

< 12

12-14

15-17

18-19

20-24

25-34

35-44

45-64

> 64

TOTAL potential new licenses/applicants _____

5. Annual days per participant _____ to _____

6. Total potential added demand _____ to _____

<u>Step 4</u> - Summarizing Net Impacts and Estimating the Effect of In-Migrant
License Demand on the Chances of Obtaining a Restricted License

<u>Step 4^a</u> - Summarizing Net Impacts

Impact area _____   Year _____

License type	Participants	Days	Other impacts^a
1. Big game			
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
2. Small game/ upland game			
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
3. Waterfowl			
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
4. Furbearers/ predators			
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

---

^{a} Sample categories include:
    A = Increased posting of private lands by landowners may reduce land
        availability
    B = Crowding on public lands may lessen the quality of the recreational
        experience for original hunters.
    C = Reduced chances for lottery.
    D = Shorter seasons and/or bag limits may be necessary to accommodate
        increased number of participants.
    E = No significant adverse impacts projected.
    F = Furbearer/predator hunting may affect the participation in and
        success of furbearer trapping.

71

<u>Step 4b</u> - Estimating the Effect of In-migrant License Demand on the Chances
of Obtaining a Restricted License

1.   License type _____a_____
     Local applicants_____
     Nonlocal applicants___b_____   In-migrant applicants___c_____
     Licenses available _____
     Odds of selection _____   Odds including in-migrants _____

----

2.   License type _____   In-migrant applicants _____
     Local applicants _____
     Nonlocal applicants _____   In-migrant applicants _____
     Licenses available _____
     Odds of selection _____   Odds including in-migrants _____

----

3.   License type _____
     Local applicants _____
     Nonlocal applicants _____   In-migrant applicants _____
     Licenses available _____
     Odds of selection _____   Odds including in-migrants _____

---

a The number of local applicants for the local hunting unit should be esti-
   mated rather than the total number of local applicants, since some
   residents may apply for another hunting unit.
b
   Applicants for the local unit, but who reside outside the area, should be
   included.
c
   The number of in-migrant applicants should be adjusted for those who ap-
   plied for this unit previously and those who apply for other units in-
   stead of the local unit.

72

INSTRUCTIONS FOR A FISHING IMPACT ASSESSMENT (WORKSHEET NO. 4)

Estimating additional fishing pressure attributable to in-migrating populations requires the same general procedure as used for hunting. As with the hunting procedures, comparisons of changing supplies and demands between future years for which data are estimated can be developed by using the FWS Human Use and Economic Evaluation procedure (U.S. Fish and Wildlife Service 1980b).

Step 1 -   Identifying local fishing opportunities

Step 2 -   Developing a profile of current resident licensees

Step 3 -   Estimating the potential number of in-migrants who will fish

Step 4 -   Estimating the potential additional fishing days, and distributing days by species

An example Worksheet No. 4 is found in Section 11.

Step 1 - Identifying Local Fishing Opportunities

This requires a review of fishing regulations and data disseminated by State game and fish departments. For the current residents of the impact area, or statewide if necessary, primary species of interest should be identified and weighted (e.g., on a scale of 100) to indicate distribution of fishing effort or time.

Step 2 - Developing a Profile of Current Resident Licensees

Maintain age and sex breakdowns to account for the disproportionate numbers of young males in the in-migrant population. Unique licensing requirements must also be considered. For example, North Dakota has a special license for senior citizens and does not require residents under the age of 16 to have a license. There are also individual and family licenses.

Step 3 - Estimating the Potential Number of In-migrants Who Will Fish

The procedure is similar to that for hunting and requires combining the participation ratios with in-migrant demographic data.

Step 4 - Estimating the Potential Additional Fishing Days, and Distributing Days by Species

This step summarizes data developed in Step 3.

Worksheet No. 4

FISHING IMPACT ASSESSMENT

<u>Step 1</u> - Identifying Local Opportunities

County/area _____

<u>Species</u>	Distribution of fishing time	<u>Local fishing sites</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Total	1.00	

Source(s) _____

_____

_____

<u>Step 2</u> - Developing a Profile of Current Resident Licensees

State/county/unit _____

License type _____   Data by: license _____

Data source(s) _____   activity _____

_____

List resident license holders by age/sex category.

Age group[a]	Impact area resident population[b]	Number of applicants	Participation ratio	Notes[c]

(example):

Males

< 16				
16-17				
18-24				
25-34				
35-44				
45-64				
> 64				

Females

(example):

< 16				
16-17				
18-24				
25-34				
35-44				
45-64				
> 64				

[a] Do not aggregate ages until completion of Step 3.
[b] From Census or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.
[c] Include participation ratios from other sources.

<u>Step 3</u> - Estimating the Potential Number of In-migrants Who Will Fish

Impact area _____ Year _____ License type _____

List in-migrants by age/sex category using data from demographic profile.

Age group	Number of in-migrants	Participation ratio	Potential new participants	Notes

(example):

Males

< 16

16-17

18-24

25-34

35-44

45-64

> 64

Females

(example):

< 16

16-17

18-24

25-34

35-44

45-64

> 64

TOTAL Potential new licenses _____

Annual days per participant _____ to _____

Total potential added demand _____ to _____

Source(s): _____

_____

Step 4 - Estimating the Potential Additional Fishing Days and Distributing Days by Species

Species	Distribution of fishing time	Additional days demanded		Other considerations[a]
		Year:_____	Year:_____	
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	1.00	_____	_____	_____

---

[a] Other considerations might include:

    A = Bottleneck or constraint at access point(s).
    B = Constraint in supply of fishing experience.
    C = Other: _____
    D = No constraints anticipated.

GUIDELINES FOR OTHER WILDLIFE-RELATED NONCONSUMPTIVE RECREATION IMPACT ASSESSMENT

Other wildlife-related recreation of primary interest to resource managers besides hunting and fishing includes off-road vehicle (ORV) use, snowmobiling, and general nonconsumptive uses of wildlife resources. Resource professionals familiar with an area may want to consider such activities and their use areas because of any of the following criteria:

1.   Activities or use areas are already creating problems for wildlife populations or key habitats, problems which are likely to be exacerbated by an increased population.

2.   Activities or use areas are likely to become problems in the near future due to the projected settlement patterns of in-migrating populations. Problems may occur because new settlements will be near key habitats or fragile resource areas, or because topography or land ownership patterns will likely channel most recreationists into a few areas.

3.   Activities or use areas are likely to become problems due to increased public access into previously remote areas. Such access may be via new roads or rights-of-way, for example.

4.   Areas which currently provide high quality nonconsumptive activities such as nature observation, are probable areas for overuse or habitat value loss due to nearby land use conversions.

Where any of the above suggest the need to address one of the following recreational activities as a generator of increased demand and/or potentially adverse impacts on wildlife, the accompanying procedures are recommended as a starting point.

Selected studies on ORV and snowmobile activity impacts are briefly reviewed in Appendix F. The greatest concern has generally come where snowmobiling is an intrusion on big game wintering grounds and the disturbance represents an additional stress to animals in a winter-weakened condition. Resource managers cite chasing and harassment as leading to unusual numbers of abortions, as well as death from exhaustion or pneumonia for some animals. Snowmobile users have been reported running over coyote and fox. Where deliberate harassment does not occur, snowmobile activity can still flush wintering animals and birds from limited and essential winter cover and thereby contribute to their overexposure. The possibility of overfishing lakes previously inaccessible during the winter has concerned resource managers in some areas. ORV use can destroy significant amounts of vegetation, and many species will avoid ORV use areas. In cases of both ORV and snowmobile use, compaction and destruction of fragile vegetation can also result in a significant loss of nest sites.

Birdwatching, wildlife photography, and scientific and naturalist uses of wildlife are all increasing; overall, nonconsumptive uses of wildlife probably equal consumptive uses nationwide. The 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of

the Interior and U.S. Department of Commerce 1982) reported nearly five times the number of active participants in nonconsumptive forms of wildlife-associated recreation (wildlife observation, photography, or feeding) than in all types of hunting combined for the United States overall; wildlife photographers roughly equalled big game hunters (about 12 million persons aged 16 and over).

Much nonconsumptive use involves human activity on foot, which generates different avoidance zones for most species than the zones created by use of mechanized vehicles. Nonconsumptive users also tend to be widely dispersed in both time (season) and area, seeking out more remote and less accessible natural areas. Nonconsumptive wildlife uses tend to be localized along trails, near water sites, and in areas of high scenic or aesthetic value. While behavioral avoidance impacts of these "appreciation" activities are difficult to quantify, some effort should be made to do so since allowing activity patterns which result in the loss of habitat value for the wildlife resource to be viewed is certainly self-defeating. Alternatively, if there are areas which currently offer high quality nonconsumptive use opportunities, but these opportunities are lost (e.g., due to displacement of wildlife), this loss of quality recreational opportunity should be of public concern.

INSTRUCTIONS FOR OTHER WILDLIFE-RELATED NONCONSUMPTIVE RECREATION IMPACT ASSESSMENT (WORKSHEET NO. 5)

This assessment includes the following steps:

Step 1 - Developing participation ratios

Step 2 - Applying participation ratios to estimate new demand

Step 3 - Converting additional annual demand to peak day demand

Step 4 - Identifying potential use areas

Step 5 - Distributing peak additional demand to use areas

Step 6 - Comparing peak day capacity to demand in use areas

Step 7 - Identifying additional impacts: snowmobile and/or ORV use

An Example Worksheet No. 5 is found in Section 11.

Step 1 - Developing Participation Ratios

Once the activity to be evaluated has been selected, recreation planners in State agencies for parks and recreation are the best source for data on State or local participation rates, as well as data on activity days per user and the areas used by current residents in the impact area. State motor vehicle departments may have information on snowmobile registration and designated use areas. Sample participation ratios for snowmobiling and ORV use are given in Tables F-1 and F-2 of Appendix F. It is preferable to use

State or area-specific data if possible. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior and U.S. Department of Commerce 1982) has 1982 State as well as National statistics on nonconsumptive wildlife use. State summaries of this survey data can be used to obtain participation ratios by age and sex for primary, nonresidential wildlife use. This represents participation in activities where involvement with wildlife was the primary purpose of the activity and trips of at least 1 mi were taken for the primary purpose of observing, photographing, or feeding wildlife.

Once the activity of interest is selected, Step 1 facilitates selection of the activity of interest and development of age and sex participation rates.

Step 2 - Applying Participation Ratios To Estimate New Demand

Line 1 - Enter age groups (Step 1, Line 1).

Line 2 - Enter the number of in-migrants by age group from Worksheet No. 1, Step 4. It may be necessary to reaggregate in-migrant age groups to make them correspond to age groups in Line 1. Table B-6 in Appendix B will be helpful if reaggregation is needed.

Line 3 - Enter ratios (Step 1, Line 2).

Line 4 - Multiply Line 2 by Line 3 entries to obtain numbers of new participants for the activity under assessment. Sum new participants and enter the total on the worksheet.

Line 5 - After totaling the number of potential new participants, enter an estimate of annual activity days per participant. State recreation planners or National survey data are the preferred sources of this information.

Line 6 - Multiply total participants by the Line 5 entry to obtain total potential new demand for the activity in the evaluation year.

Step 3 - Converting Additional Annual Demand to Peak Day Demand

Line 1 - Estimate the percentage of annual activity that occurs in peak use months. For example, if snowmobiling is the activity under evaluation and four winter months have been identified as peak months for the activity, 85 percent of snowmobile activity may be assumed to occur in those 4 months. If ORV use is under evaluation, 70 percent of the activity may be assumed to occur in the peak summer months. General nonconsumptive wildlife-related recreation is also highest during the summer months; 60 to 75 percent might be expected to occur then.

Line 2 - Enter total annual new demand for the activity (Step 2, Line 6).

Line 3 - Calculate the new demand occurring in the peak use season.

Line 4 - Enter the number of weeks in the designated peak use season.

Line 5 - Calculate the peak weekly new demand.

Line 6 - Peak weekend use is usually 70 to 80 percent of weekly use.

Line 7 - Weekend day use can be assumed to be equally divided between the 2 days.

Lines 8 and 9 - Enter values from lines 5 and 7, respectively.

Line 10 - Calculate peak day demand.

Step 4 - Identifying Potential Use Areas

Use areas are assumed to have potential problems if they are currently near recreational carrying capacity and if management to prevent overuse will be difficult to enforce. Nonconsumptive use areas of interest to resource managers may include wildlife refuges, parks, game management areas, or simply private lands where unique ecosystems or an unusually rich diversity of wildlife could be enjoyed. Primary use areas for nonconsumptive wildlife-associated recreation are usually within 50 mi.

Some snowmobile trails are officially designated by State recreation and parks agencies. A radius of 100 mi from settlement communities of interest should be sufficient to capture most snowmobile use areas. Off-road vehicle use areas may also be official or unofficial, although official use areas are scarce. Most ORV use occurs within 30 mi of communities.

Line 1 - Enter use area.

Line 2 - Current peak day use estimates at each use area are needed.

Line 3 - If peak use estimates for the future are available, they should be entered here. Population increases without new project-induced in-migration may be occurring, and it is important to include "without project" projections in the assessment. Trend extrapolation from past user trends may be used if no other projections are available.

Step 5 - Distributing Peak Additional Demand to Use Areas

Line 1 - Enter estimated peak day demand for the activity (Step 3, Line 10).

Line 2 - Estimate the percentage of local residents' activity use of the area.

Line 3 - Calculate additional future peak demand in each use area by multiplying estimated total peak demand (Line 1) by the entry in Line 2.

Line 4 - Repeat estimate of projected peak use for the area and for the evaluation year (Step 4, Line 3).

Line 5 - Line 3 plus Line 4.

Step 6 - Comparing Peak Day Capacity to Demand in Use Areas

Line 1 - Enter an estimate of the user capacity of the site in terms of day use, based on a recreational carrying capacity for the area which assures no displacement of wildlife populations. The determination of recreational carrying capacity at existing use areas will require the user to question current limitations of facilities (e.g., parking, trails) or the limitations of the resource base (e.g., fragile areas, sensitive species, etc.). Most managers familiar with an area and its historical visitation trends can offer reasonable estimates of recreational carrying capacity.

Line 2 - Enter projected peak day demand (Step 5, Line 5).

Line 3 - Calculate surplus or deficit. Identify needs for nonconsumptive activities where supplies are less than forecast demand and recreational carrying capacity will be exceeded unless management action is taken to limit access.

Based on Step 6 results, use areas with recreational carrying capacities less than the projected peak demand should be identified. Projected total peak demand which exceeds recreational carrying capacity of an area can result in any of the following losses in quality of the recreational experience: crowding, wildlife being displaced from the area through behavioral avoidance, damage to ecologically fragile areas, or necessitating management changes to limit users.

It is important that the carrying capacity figure refer to the activity under evaluation and not necessarily total recreational use.

Step 7 - Identifying Additional Impacts: Snowmobile and/or ORV Use

For these two types of activities it is assumed that there is considerable potential for adverse impacts on habitat value with substantially increased levels of human activity. To estimate what these impacts might be requires major assumptions of habitat loss and/or habitat value decline as a function of the level of vehicle use, the evaluation species, and existing habitat.

(a) Select wildlife evaluation species of primary concern in projected use areas. For snowmobile use areas, it is assumed that big game

will be the focus of evaluation. In ORV use areas, avifauna may be the focus.

(b) Prepare habitat maps for the evaluation species for each use area. Resource managers can use habitat evaluation procedures or some other professional method to assess the habitat value of the use areas for the evaluation species. The habitat map should be for the season of use by recreational vehicles and, at the minimum should identify and evaluate key habitat for the evaluation species.

(c) Prepare impact overlay maps and estimate habitat losses. Maps should suggest current recreational use levels and threshold use levels (recreational carrying capacity) on an areal unit basis. Trails where activity will be primarily linear and clearings where use will be random should be mapped.

Combining habitat maps and impact overlay maps, examine the permanent (habitat loss from ORV use) impact area and estimate losses of evaluation species. Worksheet No. 5 suggests standards for habitat loss as a function of vehicular use. Habitat evaluation procedures are needed to convert habitat loss to animal (numbers) loss. Add to this the number of animals displaced by behavioral avoidance. Wildlife species respond differently in terms of the consistency and regularity of encroachment as well.

Avoidance zones are not necessarily permanent habitat loss. Use may be reduced and habitat rendered less effective, though. If avoidance of areas would result in poor nutrition for the animals on adjacent lands, due to either habitat quality or overcrowding, treat these losses as permanent.

(d) Summarize wildlife losses from projected recreation vehicle activity in terms of animals lost permanently and animals displaced.

Worksheet No. 5

OTHER WILDLIFE-RELATED NONCONSUMPTIVE RECREATION IMPACT ASSESSMENT

<u>Step 1</u> - Developing Participation Ratios

Impact area _____

Activity type _____

1. <u>Age group</u>   2. <u>Participation ratio</u>

<u>Males</u>

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

<u>Females</u>

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

Data source(s): _____

_____

84

<u>Step 2</u> - Applying Participation Ratios to Estimate New Demand

Impact area _____   Year _____

Activity type _____

1. Age group (Step 1, Line 1)	2. No. of in-migrants (Worksheet 1, Step 4)	3. Participation ratio (Step 1, Line 2)	4. Potential new participants

<div align="center">Males</div>

1. Age group (Step 1, Line 1)	2. No. of in-migrants (Worksheet 1, Step 4)	3. Participation ratio (Step 1, Line 2)	4. Potential new participants
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

<div align="center">Females</div>

1. Age group (Step 1, Line 1)	2. No. of in-migrants (Worksheet 1, Step 4)	3. Participation ratio (Step 1, Line 2)	4. Potential new participants
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

TOTAL Potential new
    participants _____

5. Annual days per
    participant _____

Source(s): _____

6. Total potential added
    demand _____

<u>Step 3</u> - Converting Additional Annual Demand to Peak Day Demand

Impact area _____   Year _____

Activity _____

Peak months for the activity _____

1. Percent annual activity occurring in peak months	2. Total annual activity days (Step 2, Line 6)	3. Activity days in peak season	4. No. of weeks in peak season	5. Estimated peak weekly demand
_____ x	_____ =	_____ ÷	_____ =	_____

6. Estimated percent weekend use: _____

7. Estimated percent peak day use = _____ ÷ 2

8. Estimated peak weekly demand (Line 5)	9. Estimated percent peak day use (Line 7)		10. Estimated peak day demand
_____ x	_____	=	_____

<u>Step 4</u> - Identifying Potential Use Areas

County/impact area   _____   Year _____

Activity type   _____

1. Use area (current or planned):   _____

2. Peak day demand estimate: _____

3. Projected peak day demand estimate: _____

86

Step 5 - Distributing Peak Additional Demand to Use Areas

County/impact area: _____

Activity type: _____

Use area: _____

1. Estimated additional peak day demand (Step 3, Line 10): _____

2. Estimated percent of impact area usage: _____

3. Estimated additional peak day demand at area (Line 1 x Line 2): _____

4. Projected nonproject peak day demand (Step 4, Line 3): _____

5. Projected total peak day demand (Line 3 + 4): _____

Source(s): _____

Step 6 - Comparing Peak Day Capacity to Demand in Use Areas

Year _____

Area	1. Projected peak day capacity	2. Projected peak day demand (Step 5, Line 5)	3. Surplus or Deficit
____	_____ -	_____ =	_____
____	_____ -	_____ =	_____

Where a deficit supply is indicated for wildlife-related nonconsumptive recreation, it may be useful to convert the projected demand attributed to in-migrants into estimates of public land area needed with wildlife-related nonconsumptive use opportunities, given whatever rule of thumb (land acreage: visitor day) current use areas may experience. Suggested additions to available wildlife areas could be identified by resource managers.

Step 7 - Identifying Additional Impacts: Snowmobile and/or ORV Use

Wilshire et al. (1978) estimated that 4-wheel off-road vehicles destroy about 1 ha in traveling 23 km and that 2-wheel off-road vehicles destroy at least 1 ha in traveling 77 km. (This equals about 2.5 acres/15 mi for 4-wheel vehicular activity and 2.5 acres/50 mi for 2-wheel activity.) These estimates can be converted to activity day losses if assumptions can be made about the number of recreationists per vehicle, distance traveled per vehicle per day, and whether vehicles tend to follow each other or seek new routes. Three persons per 4-wheel vehicle and two vehicles per group would constitute 6 activity days. Assuming such a group drove about 15 mi with each vehicle on a different track, 30 vehicle miles or about 5 acres would be the impact area.

87

Assumptions should be tailored for the use area. For 2-wheel vehicles, 1.5 persons per vehicle and 4 vehicles per group would equal 6 activity days. Assuming 10 mi per vehicle, and half of it on the same track, 6 activity days would equal about 25 mi, or about 1.25 acres lost.

Again, assumptions pertinent to actual user trends in the area should be used.

After habitat maps are prepared, impact overlay maps should be prepared. For ORV areas, assume vegetation loss of 5 acres per 6 activity days where use is primarily 4-wheel-drive vehicles and 1.2 acres per 6 activity days where use is primarily dirt bikes. Assume effective displacement of big game from adjacent habitat, based on impact zones suggested in Table 5, Section 3.

ORV use area	Additional peak weekly activity days (beyond carrying capacity)		Predominant type used 4-wheel	2-wheel	Permanent loss
1 _____	_____ ÷ 6 =	____ x	(5 acres) or	(1.2 acres) =	_____
2 _____	_____ ÷ 6 =	____ x	(5 acres) or	(1.2 acres) =	_____

ORV use area	Permanent acres lost	Percent overlay with habitat of evaluation species	Acres lost to evaluation species	Carrying capacity	Estimated animals lost
1 _____	_____ x	_____ =	_____ x	_____ =	_____
2 _____	_____ x	_____ =	_____ x	_____ =	_____
				Total =	_____

For snowmobile use areas, assume displacement of big game from snowmobiling lanes and clearings as well as adjacent habitat within 325 to 625 ft (based on amount of cover habitat offers).

SECTION 5

POACHING IMPACT ASSESSMENT

GUIDELINES FOR A POACHING IMPACT ASSESSMENT

While poachers are commonly envisioned as secretive individuals who kill game animals during the closed season, a poacher is actually anyone who hunts or fishes illegally. Thus, poaching includes attempting to catch fish without a license as well as spotlighting deer.

All poaching impacts wildlife to some extent. Activities such as spotlighting deer, exceeding bag limits, and out of season hunting decrease populations with each illegal kill. When those kills involve females or young animals, the population potential is also decreased. Less obvious impacts are caused by such violations as failure to buy a license, which decreases management funding, or littering, which may take enforcement personnel away from more important pursuits. Conservation officers (the term is used here to denote all enforcement personnel) are often responsible for the apprehension of all persons illegally hunting or fishing. Consequently, the extent and nature of all such illegal activities will influence enforcement personnel effectiveness.

When a poaching problem has been predicted, it next becomes necessary to identify the probable extent of that problem. Unfortunately, no method has been devised to determine accurately the number of violations actually occurring. Simulations have been used to estimate big game losses (Vilkitis 1968; Pursley 1977) and compliance rates for fishermen (Stork and Walgenbach 1973). Those simulations involved placing a known number of real or simulated violations or violators in the field and then recording the number identified by conservation officers. The fraction of observed to known (simulated) violations was then extrapolated to the total number of observed infractions to calculate total violations. So few simulated violations were reported that the only conclusions were that big game poaching was largely ignored in New Mexico (Pursley 1977) and Idaho (Vilkitis 1968) and that the real violation rate is probably at least nine times the observed rate. Tenuous estimates of illegally harvested big game equaled or exceeded the legal harvest.

Estimates of hunter compliance to sporting regulations have also been employed; however, the intent was usually to measure enforcement effectiveness (McCormick 1968; Hussain 1977). Those estimates were based on the proportion of hunters contacted by conservation officers who were in compliance with the law. Cowles et al. (1979) detailed some of the problems with this technique. Compliance ranged from 61.3 percent for Michigan small game hunters (Hussain 1977) to 85.5 percent for California deer hunters (McCormick

89

1968). Wright (1980), using a randomized response technique, estimated compliance among Iowa farmers to deer hunting regulations as between 89.5 and 93.3 percent. This was the highest compliance rate found in the literature.

Unfortunately, data required for compliance rate calculations are not universally available. Even if they were, it is possible that social changes following in-migration would render them nonapplicable to a rapidly changing situation. Both compliance and simulation data require extended data collection and can be costly.

For the purpose of this workbook it was deemed best to develop a process that incorporated data that were universally available, represented a broad range of the potential variability, and could be bounded by confidence intervals. A regression approach satisfied those requirements. Data were gathered from Morse (1958, 1963, 1968, 1972, 1976, 1980). He has tabulated enforcement data quadrennially since 1958 for the 11 contiguous Western States and for all States since 1968. During the span of these data, the western population has increased dramatically, due primarily to in-migration (U.S. Bureau of the Census 1981). It is presumed that changes in the enforcement data were reflective of the population change and that variation in the data represented the variability throughout the West. Several regressions were derived, but only the relationship between the number of licenses sold (X) and the number of arrests (Y), or the square root of the number of arrests ($\sqrt{Y}$) were acceptable. Morse (1963) also determined that total arrests were proportional to the number of licenses sold. The inherent assumptions for this procedure are that the total number of arrests is indicative of total violations and that license sales indicate outdoor activity levels. Most arrests reported in these data probably represent in-season violations. The derived regression equations were:

Total number of arrests (Y) = 0.0069 (number of licenses, X) - 518.02   (1)

Total number of arrests (Y) = [0.00004 (number of licenses, X) + 28.90]^2 (2)

Total number of arrests (Y) = 0.0054 (number of licenses, X) + 102   (3)

Six States (California, New Mexico, Oregon, Utah, Washington, and Wyoming) had minimum standard errors of the point estimate when Eq. 1 was employed. Standard errors are presented in Table 6. The data used in Eq. 1 yielded a correlation coefficient of $r = 0.9267$ (dr = 63, $P < 0.001$). Point estimates for number of arrests were best described for Arizona, Colorado, Idaho, Montana, and Nevada by Equation 2 (correlation $r = 0.8978$, $P < 0.001$). For North Dakota, a Midwestern regression analysis was used; Eq. 3 yielded a correlation coefficient of $r = 0.8227$ ($P < 0.001$).

The standard errors presented in Table 6 may be used to predict the range of expected violations. Where poaching opportunities are abundant and in-migrant profiles resemble violator profiles, the upper limit might be chosen for a point estimate. The lower limit could be chosen for contrasting situations. Point estimates may also be generated using the equation appropriate to the State. Finally, point estimates based on local area data (number of arrests per 10,000 license sales) can be used.

90

Table 6. Regression equations, correlation coefficients, and standard errors of the point estimate for the relationship between the number of sportsman licenses sold (X) and the number of arrests reported (Y). Data are from Morse (1958, 1963, 1968, 1972, 1976, 1980).

State	Regression	r	P	Standard error
California	$Y = 0.0069(X) - 518.02$	0.9267	0.001	2,924
Oregon				4,707
Utah				762
Washington				1,609
Wyoming				374
New Mexico				621
Colorado	$Y = [0.00004(X) + 28.90]^2$	0.8978	0.001	1,610
Arizona				703
Idaho				990
Montana				559
Nevada				458
North Dakota	$Y = 0.0054(X) + 102$	0.8227	0.001	298

The predicted number of arrests is an index to the level of expected violations. To estimate the predicted number of actual violations, the proportion of observed to undetected violations must be determined. Pursley (1977) estimated that 90.35 to 99.64 percent of all New Mexico violations were never detected (Table 7). Similar results were obtained by Vilkitis (1968). He estimated that an Idaho big game poacher (closed season) had a 99.5 percent chance of escaping detection. To estimate open season arrest rates (number of arrests ÷ number of violators), compliance and arrest data from Michigan were analyzed (Hussain 1977). Between 1971 and 1973 the mean arrest rates were 1.61, 1.09, 1.97, and 1.49 percent for big game, small game, fishing, and all activities, respectively (Table 7). These results approximate those of Pursley (1977) and Vilkitis (1968). The average arrest rate for these studies was 2.33 percent. This value may be used when an estimate for the specific impact area is lacking.

91

Table 7. Percentage arrest rates reported or calculated from the literature.

State	Year	Activity	Percent Arrest rate	Source
Idaho	1967	Big game	0.5	Vilkitis (1968)
New Mexico	1976	Big game	9.65-0.36	Pursley (1977)
Michigan	1971	Big game	1.72	Hussain (1977)
		Small game	1.05	
		Fishing	2.03	
		All activity	1.55	
	1972	Big game	1.72	
		Small game	1.03	
		Fishing	2.19	
		All activity	1.53	
	1973	Big game	1.39	
		Small game	1.20	
		Fishing	1.68	
		All activity	1.39	
Average			2.33	

The total number of violations may now be estimated by the following procedures:

1. Projecting the number of sportsmen expected to participate in hunting and fishing

2. Summing all sportsmen for an estimate of license sales

3. Calculating the number of expected arrests using an appropriate regression. A unique regression should be calculated for an impact area whenever possible

4. Determining the total number of violations by dividing the total number of arrests by the estimated arrest rate

Guidelines include:

1. The regressions are based on long term averages and broad geographical areas. Consequently, they work best at high levels of license sales.

2. The regressions may not be specifically applicable to some localized areas, but can be used as guidelines.

3. Each specific area should be analyzed with respect to its position relative to the geographic mean. For example, an area with a high rate of arrests per licenses should be analyzed such that the geographic mean provides the minimum estimate or an objective to be achieved through mitigation.

4. Localized data and site-specific regressions should be used wherever possible to predict the minimum possible extent of the problem. Poaching is not likely to decline following in-migration; an increase is predictable. Historic data will probably tend to underestimate the future problem. Geographic data contain areas with minimal as well as severe problems and thus demonstrate the extent of those problems.

5. Ideally, each area should be analyzed using site-specific data and data from a similar and proximal area that has experienced recent in-migration. The concept is sound and consistent, but the numbers should be re-evaluated for each situation.

INSTRUCTIONS FOR A POACHING IMPACT ASSESSMENT (Worksheet No. 6)

The material presented in this section explains the following assessment procedure:

Step 1 - Evaluating the poaching potential

Step 2 - Predicting the total number of arrests

Step 3 - Predicting the total number of additional violations

Step 4 - Distributing violations by type

Step 5 - Estimating wildlife losses due to poaching

Representative data and an example Worksheet No. 6 are found in Section 11.

Step 1 - Evaluating the Poaching Potential

Step 1 presents a series of questions, based on previously described violator profiles, that were formulated to evaluate the probability of a poaching problem associated with substantial human in-migration into an area. Numerous "yes" answers to these questions would indicate a large number of potential violators and an ample opportunity to poach.

When either an opportunity to poach or an influx of potential violators is anticipated, an increase in illegal activity can be expected. When both situations existed in northwestern Colorado, a very real problem resulted (Daneke, pers. comm).

Step 2 - Predicting the Total Number of Arrests

This step is completed for each year for which poaching impact estimates are desired. This step requires prior completion of Worksheet No. 3 - Hunting Impact Assessment and Worksheet No. 4 - Fishing Impact Assessment.

Line 1 - Enter the sum of additional licensees for hunting and fishing

Line 2 - Referring to Table 6, select the regression equation appropriate for the State where the impact area is located. Enter the appropriate coefficient for x from the column titled "Regression"

Line 3 - Referring to Table 6, enter the appropriate Y intercept, which may be a positive or negative number

Line 4 - Compute as shown

Line 5 - Referring to Table 6, enter either the line 4 value or this value squared, depending on the State

Line 6 - From Table 6, enter the appropriate standard error

Line 7 - Compute as shown

Line 8 - Repeat the line 5 entry

Line 9 - Repeat the line 6 entry

Line 10 - Compute as shown

Line 11 - Enter the range shown between values in line 7 (maximum) and line 10 (minimum). Regard negative minimums as zero.

Optional: If point estimates are desired:

Line 12 - If historical data for the impact area are available which relate the number of arrests to the number of hunting and fishing licenses sold, calculate a point estimate of the number of arrests, assuming the number of licenses in line 1:

$$\frac{\text{historic arrests}}{\text{historic license sales}} = \frac{\text{new arrests}}{\text{new license sales}}$$

Line 13 - Calculate an alternative point estimate using the selected regression equation. For example, if Equation 3 were selected, the point estimate, assuming the number of licenses in line 1, would be based on this ratio:

$$\frac{54 \text{ arrests}}{10,000 \text{ license sales}} = \frac{\text{new arrests}}{\text{new license sales}}$$

Line 14 - Select a point estimate using either historic data (line 12) or the regression equation (line 13)

Step 3 - Predicting the Total Number of Additional Violations

    Line 1 - Enter either the range of values (Step 2, line 11) or the
              point estimate (Step 2, line 14)

    Line 2 - An area-specific arrest rate can be entered or the suggested
              value can be used

    Line 3 - Compute as shown

Step 4 - Distributing Violations by Type

    By assuming that the distribution of arrests represents the distribution
of all violations, it becomes possible to allocate expected total violations
into various categories. Dalton (pers. comm.) estimated that in Utah about
70 percent of all apprehended violations are of a nature that wildlife are
reduced in number. Morse (1972, 1976, 1980) presented mean percent arrests
by category for the West. Those data indicated a mean distribution of 31 per-
cent game, 53.7 percent fishing, 2 percent nongame violations, and 13.3 per-
cent other arrests. These data may be used, where reasonable, when localized
data are absent. However, where opportunities for one or more of these ac-
tivities vary considerably from the others, the real distribution will proba-
bly vary accordingly. A more refined categorization (e.g., deer hunting
violations, trout fishing, grouse hunting, etc.) would be desirable when
the data base permits.

Step 5 - Estimating Wildlife Losses Due to Poaching

    This process requires assumptions on the number of animals killed per
violation. When Step 4 is completed on a refined scale, it becomes possible
to attribute losses to specific wildlife populations. Losses are calculated
by multiplying the previously observed mean kill for each animal group (big
game, small game, deer, grouse, etc.) per violation by the expected number
of violations. If the age and sex distributions of illegal kills are known,
it would also be possible, through life table techniques, to project the ef-
fects of illegal kills on the population potential. The level of resolution
and the accuracy of any predictions will depend on the localized data base.

95

Worksheet No. 6

POACHING IMPACT ASSESSMENT

Step 1 - Evaluating the Poaching Potential

This is a qualitative process based on yes/no questions. A preponderance of yes answers would indicate a high risk situation for wildlife violations.

A. Are poaching opportunities a characteristic of the impact area?

1. Is there a diversity and abundance of game within or near the impact area?   Yes___ No___

2. Is there an extensive road system or are game otherwise largely accessible?   Yes___ No___

3. Are proposed project activities rural?   Yes___ No___

4. Do work shift changes place workers in or near wildlife habitat late at night or during peak periods of wildlife activity?   Yes___ No___

5. Are in-migrants expected to have free time at night or on weekends?   Yes___ No___

6. Do rural workers commonly carry firearms or other sporting equipment?   Yes___ No___

7. Could in-migrants encounter difficulties in understanding the local game regulations?   Yes___ No___

8. Are residency requirements long relative to the anticipated tenure of in-migrants?   Yes___ No___

9. Are rural areas sparsely settled?   Yes___ No___

10. Do residents view poaching as an unimportant victimless crime?   Yes___ No___

11. Is there currently a poaching problem that might promote a similar attitude amongst in-migrants?   Yes___ No___

12. Are there monetarily important species within or near the impact area?   Yes___ No___

Total Yes___

Total No___

96

B. Do in-migrant profiles match known violator profiles?

1. Do young adults (primarily 20- to 39-year olds) comprise a large segment of the anticipated in-migration? (from Worksheet 1) Yes___ No___

2. Are males expected to predominate in the expected in-migration? (from Worksheet 1) Yes___ No___

3. Are many of the expected children likely to be males in the mobile (i.e., legal driving age) teenage groups? (from Worksheet 1) Yes___ No___

4. Are large numbers, relative to current levels, of outdoor recreationists expected? (from Worksheet 3) Yes___ No___

5. Are rural workers expected to carpool, work in teams, or otherwise form groups? Yes___ No___

6. Are alcoholic beverages readily available within the impact area? Yes___ No___

7. Do many of the anticipated occupations have low education requirements? Yes___ No___

8. Are a large number of the in-migrants expected to rent their homes? (Worksheet 2) Yes___ No___

9. Are many in-migrants expected to hold more than one job? Yes___ No___

10. Are in-migrants likely to live close to game areas? (Gravity Model, Worksheet 1) Yes___ No___

11. Are many of the in-migrants expected to be transients? Yes___ No___

Total Yes___

Total No___

Personal evaluation _____

_____

_____

Step 2 - Predicting the Total Number of Arrests

County/impact area _____   Year _____

1. Estimated number of   2.   3. The Y
   licenses for hunters   The slope from   intercept from   4. Point
   and anglers (Work-   the appropriate   the appropriate   estimate
   sheet 3, Step 4 and   regression   regression   of the
   Worksheet 4, Step 4)   (Table 6)   (Table 6)   regression

   _____ x   _____ +   _____ =   _____

5. Point estimate (or   6.
   point estimate   1 standard   7. Predicted maximum
   squared, when   error   number of arrests
   appropriate)   (Table 6)   following in-migration

   _____ +   _____ =   _____

8. Point estimate   9.
   (or point   1 standard   10. Predicted minimum
   estimate   error   number of arrests
   squared)   (Table 6)   following in-migration

   _____ +   _____ =   _____

11. Range: _____

Optional:

12. Point estimate (historical data, where available): _____

13. Point estimate (selected equation): _____

14. Point estimate chosen: _____

Step 3 - Predicting the Total Number of Additional Violations

                                  2. Arrest rate
              1. Predicted number   Std.   Your   3. Predicted
                 of arrests   value   value =   violations

              _____ ÷   0.0233 _____   _____

98

Step 4 - Distributing Violations by Type

Activity	Percent of all violations		Predicted number of violations (Step 3)		Number of activity specific violations
Hunting	0.31	x		=	
Deer hunting		x		=	
Small game		x		=	
Fishing	0.54	x		=	
Nongame	0.02	x		=	
Other	0.13	x		=	
Total	1.00				

Step 5 - Estimating Wildlife Losses Due to Poaching

Activity/species	Predicted number of violations		Mean kill per violation		Predicted losses
		x		=	
		x		=	
		x		=	
		x		=	

99

SECTION 6

DEER-VEHICLE ACCIDENT ASSESSMENT

GUIDELINES FOR A DEER-VEHICLE ACCIDENT ASSESSMENT

One of the most visually apparent impacts on wildlife from increased human activity in an area is the annual toll of wildlife, primarily deer, killed in vehicle-animal collisions. Suggesting a procedure for projecting such losses is very difficult because of the role of site-specific factors in determining these losses. Weather patterns, vegetative cover near roads, volume and speed of traffic, wildlife densities, and the number of wildlife crossings will all affect road kills. Road kill problem areas typically have one or more of the following characteristics:

1. roads passing through winter, summer, or yearlong deer (or pronghorn) range;

2. roads with dense vegetation within 50 ft of one or both sides;

3. roads with greatest traffic volumes in early morning or early evening and/or heavy or fast-moving traffic;

4. roads with median strips or rights-of-way which form steep troughs; and

5. roads with frequent curves which shorten visibility.

Selected studies on highway deer mortality are reviewed in Appendix H. The most detailed guidance available on quantifying road kills at problem stretches was offered in the form of historical relationships between traffic volumes, road kills, deer crossings, and deer counts (Reed, pers. comm.). These ratios were based on data collected over 8 yr, primarily on Colorado Highway 82 near Glenwood Springs.

INSTRUCTIONS FOR A DEER-VEHICLE ACCIDENT ASSESSMENT (Worksheet No. 7)

A rule-of-thumb procedure for a site-specific assessment of deer losses is suggested. Estimating increased deer mortality due to increased vehicle collisions in a developing area may require consideration of future traffic on existing roads where collisions are already occurring or on new or previously "nonproblem" roads with high potential to become problem areas. The

suggested procedure to quantify these losses assumes road kills are a function of the number of animal crossings or animal roadside counts and of traffic volume. The procedure was developed for deer accidents, but there may be similar procedures that could be developed if data on other big game, e.g., pronghorn, were available to the analyst. The steps included are:

Step 1 - Identifying problem road segments

Step 2 - Estimating current total annual road kills (Method 1)

Step 3 - Estimating current total annual road kills (Method 2)

Step 4 - Selecting a projection method

Step 5 - Projecting future road kills

Step 6 - Summarizing potential impacts

Representative data and an example Worksheet No. 7 are found in Section 11.

Step 1 - Identifying Problem Road Segments

Worksheet No. 7 facilitates the listing, by county, of locations on specific highways which are currently road kill problem areas. Unless otherwise designated, it is assumed that deer are the species of interest. Annual reported kills and average daily traffic (ADT) data for the area should be available. State game managers and/or State highway patrol officers are the best source for information on reported road kills. State highway agencies (planning departments) should be able to provide maps showing ADT by section of highway.

Step 2 - Estimating Current Total Annual Road Kills (Method 1)

For each location of interest, an estimate of total road kill occurring under present conditions should be made.

Line 1 - Enter reported annual mortality for the road segment under evaluation (from Step 1).

Line 2 - Enter an estimate of reported road kills as a percentage of actual road kills. A range of 0.10 to 0.15 has been suggested by several wildlife managers as representative of the road kill problem in mountain States. In plains States, where road kills are more visible to permanent residents or problem areas are close to communities, reported kills may more closely approximate actual kills, e.g., 50 percent or more.

Line 3 - Compute total estimated annual road kills.

101

<u>Step 3</u> - Estimating Current Total Annual Road Kills (Method 2)

Develop two additional estimates of current total kills for each loca-
tion based on the assumption that kills are a function of (a) the number of
animal counts and/or crossings and (b) traffic volume.

Line 1 - Enter ADT for the road segment under evaluation.

Line 2 - Enter the estimated "crossings per kill" ratio corresponding
to the ADT (See Figure 9).

Line 3 - Estimate the average daily animal crossings at the location in
the road kill season.

Line 4 - Repeat Line 2 entry.

Line 5 - Compute estimated daily kill.

Line 6 - Enter an estimate of the number of days in the year for which
animal crossing estimates are relevant.

Line 7 - Compute estimated annual kills based on ADT/animal crossing
method.

Line 8 - Estimate the average daily animal count occurring at the same
location in the road kill season.

Line 9 - Enter the estimated "count per kill" ratio corresponding to
the ADT (see Figure 10).

Line 10 - Compute estimated daily kill.

Line 11 - Enter an estimate of the number of days in the year for which
animal count estimates are relevant.

Line 12 - Compute estimated annual kills based on the ADT/animal count.

<u>Step 4</u> - Selecting a Projection Method

The estimated annual kill from reported data (Step 2) should be compared
to estimates derived using the ADT/animal crossings and ADT/animal count
methods (Step 3). The method which provides estimates closest to the Step 2
estimates may be selected for projecting future kills under increased traffic
volume.

<u>Step 5</u> - Projecting Future Road Kills

A suggested technique is to project average daily traffic (ADT) volume
occurring in the target year and attributable to the project, then apply the
method selected in Step 4. The projected ADT on major roads should be part
of an energy company's environmental impact statement or can be obtained

102
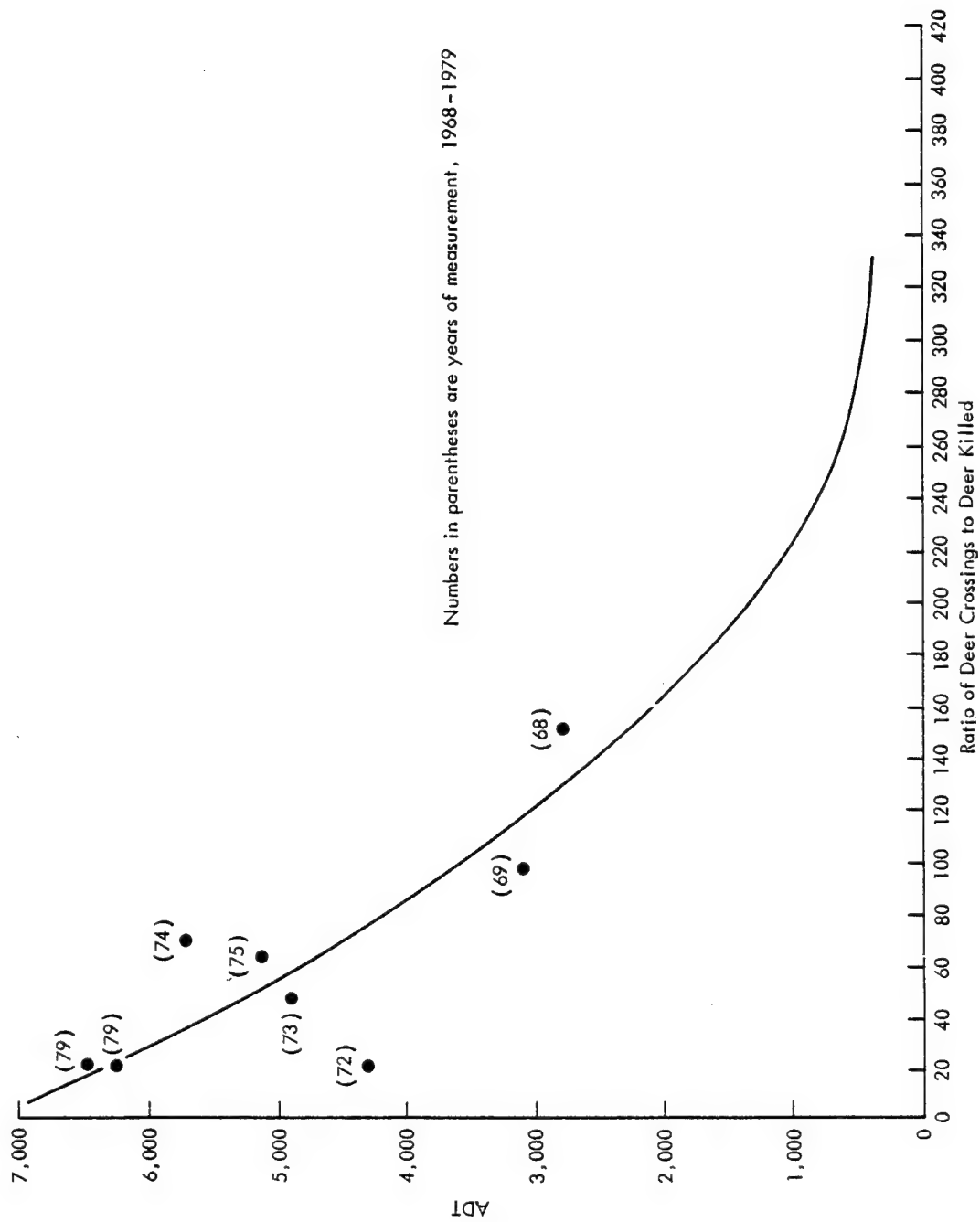
Figure 9. Estimated relationship between average daily traffic (ADT) volume and number of deer crossings per kill. Data from State Highway 82 near Glenwood Springs, CO, 1968-1979.
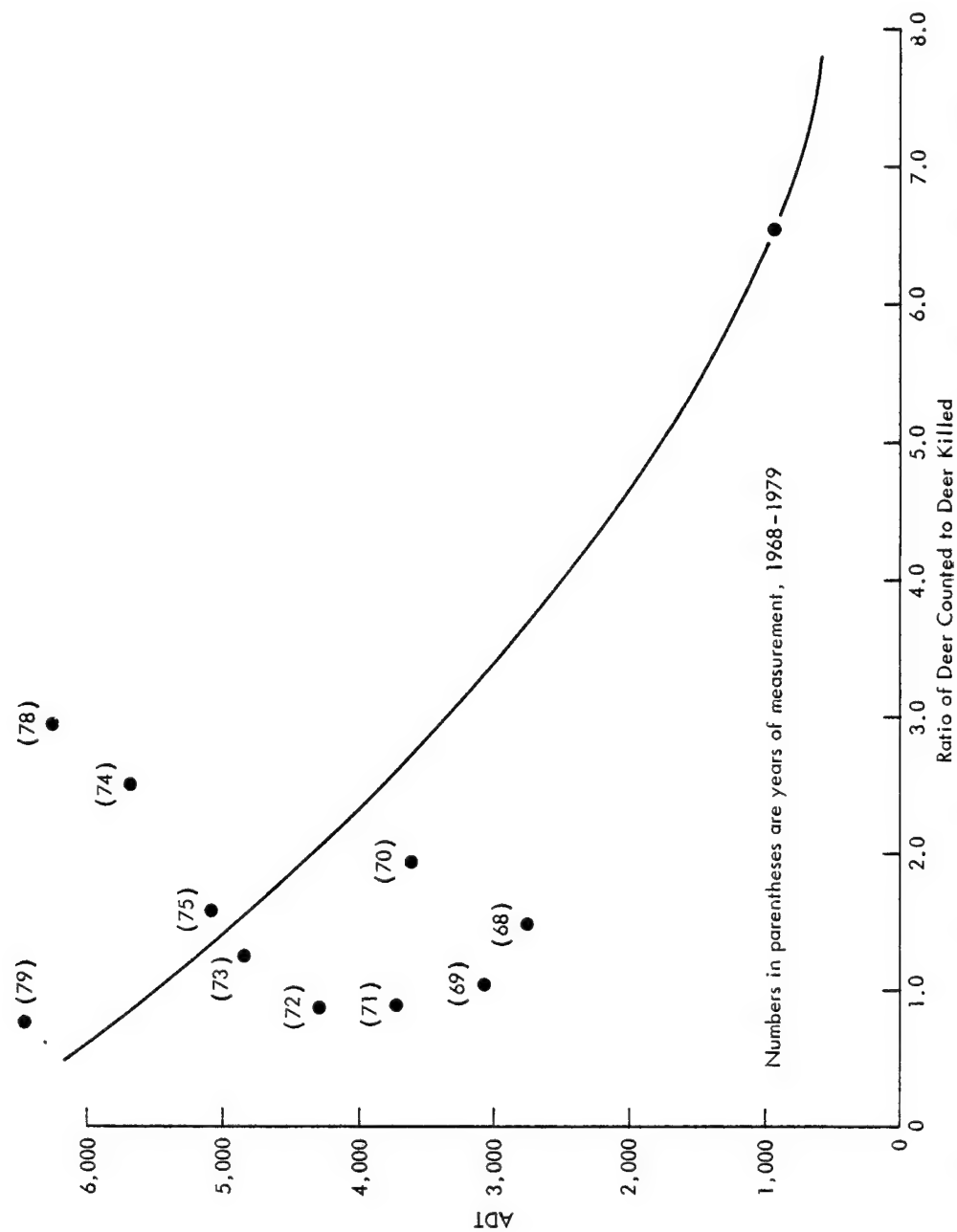
Figure 10. Estimated relationship between average daily traffic (ADT) volume and ratio of deer counted to deer killed. Data from State Highway 82 near Glenwood Springs, CO, 1968-1979, except far right data point, which was adjusted from data for two-lane State Highway 13.

104

from local or State transportation planners. Care should be taken to identify that portion of the projected increase which is attributable to the project. Estimating counts or crossings on future roads (roads proposed for construction) may require finding comparable situations, i.e., estimating counts or crossings in an area where a new road will be built based on counts or crossings near existing roads through comparable habitat. Where the choice is available, estimates of crossings may be preferable to estimates of counts.

Step 6 - Summarizing Potential Impacts

This step is the summation of estimated deer kills on problem stretches throughout the study area for the target year.

Worksheet No. 7

DEER-VEHICLE ACCIDENT ASSESSMENT

Step 1 - Identifying Problem Road Segments

County _____
Species_____

Current road kill problem areas:

	Location/Highway	Annual reported mortality	Average daily traffic
A.	_____	_____	_____
B.	_____	_____	_____

Step 2 - Estimating Current Total Annual Road Kills (Method 1)

Road segment: _____

		Percent of total		
1. Reported annual mortality	2.	kills actually reported	3. Estimated annual kill	
		Range Value		
_____	÷	(.10-.15) _____	=	_____

Step 3 - Estimating Current Total Annual Road Kills (Method 2)

Road segment: _____

1. Average daily traffic: _____
2. Ratio of crossings per kill at this ADT (see Figure 9): _____

3. Estimated average daily animal crossings ÷ 4. Ratio of crossing per kill (line 2) = 5. Projected daily kill

_____ ÷ _____ =

x _____ 6. Days of season
= _____ 7. Projected annual kill, ADT/crossings method

8. Estimated average daily animal count ÷ 9. Ratio of count per kill (Figure 10) = 10. Projected daily kill

_____ ÷ _____ =

x _____ 11. Days of season
= _____ 12. Projected annual kill, ADT/count method

<u>Step 4</u> - Selecting a Projection Method

Method	Annual kills	Variation from reported kills (line 1 ÷ line 2 or 3)
1. Estimated kill (Step 2, Line 3) = _____		
2. Crossings method (Step 3, Line 7) = _____		_____
3. Count method (Step 3, Line 12) = _____		_____

<u>Step 5</u> - Projecting Future Road Kills

Step 5a - ADT/animal crossings method

Road segment: _____   Year: _____

1. Projected ADT: _____

2. Projected annual   3. Estimated animal   4. Projected future   5. Variation
   animal crossings   crossings per kill   annual kills   factor
                         (see Figure 9)   (optional)

_____   ÷   _____   =   _____   x _____

                                                         = _____
                                                         Projected future
                                                         annual kills

Step 5b - ADT/animal count method

Road segment: _____

1. Projected ADT: _____

2. Projected annual   3. Estimated animal   4. Projected future   5. Variation
   animal count   counts per kill   annual kills   factor
                         (see Figure 10)   (optional)

_____   ÷   _____   =   _____   x _____

                                                         = _____
                                                         Projected future
                                                         annual kills

<u>Step 6</u> - Summarizing Potential Impacts

Road segment	Estimated annual road kill
_____	_____ animals
_____	_____ animals
_____	_____ animals
Total	_____ animals

107

SECTION 7

DOG PREDATION IMPACT ASSESSMENT

GUIDELINES FOR A DOG PREDATION IMPACT ASSESSMENT

The Colorado Division of Wildlife conducted a mail survey of wildlife
management agencies in each State and Canadian province in an effort to
determine the extent to which free-roaming domestic dogs impact wildlife
populations (Pre, Moser, and Whitaker 1978). Overall, wildlife losses to
free-roaming domestic dogs usually were found to be minor. But certain
geographic and environmental conditions, when they exist together, were
consistently reported as placing wildlife in extreme vulnerability:

1. large populations of free-ranging dogs;
2. difficult terrain;
3. severe winter conditions including deep and/or crusted snow; and
4. populations of white-tailed deer, mule deer, elk, or pronghorn.

Locating new mountain subdivisions on critical winter game ranges has
led to a substantial drain on some deer and elk herds, such as those in the
Denver-Boulder, Aspen, Vail, and Steamboat Springs, CO, areas. Wildlife
managers familiar with the impact of free-ranging dogs on wildlife around
new towns and resort areas stress the significance of these losses. For
example, one year the deer kill by dogs was higher than the take by hunters
in the Aspen area; and this count included only the deer which were found
(Whitaker, pers. comm.). Another example occurred near the town of Minturn,
CO, where a winter range that previously sustained a herd of 500 mule deer
is no longer utilized by deer due to dog predation and harassment. In
southeastern Utah, one study of radio-collared deer reportedly showed that
dogs were a more significant factor in winter kill than either predators or
natural forces (Dalton, pers. comm.)

Deer are not the only big game species impacted. Pronghorn losses to
dogs were as significant as deer losses in Wyoming during the winter of
1980-1981 (Cleveland, pers. comm.). Some biologists feel that statewide
losses of pronghorn from dog predation probably reach or exceed losses of
deer to dogs in Wyoming.

Denney (1974) reported that a nationwide mail survey indicated that
86 percent of State wildlife agencies believed uncontrolled dogs were a
problem to wildlife. Furthermore, 71 percent of State departments of agri-
culture indicated there was a problem with livestock being harassed and
killed by dogs.

Based on conversations with wildlife managers, the magnitude of impact appears to depend on: (a) the season, with winter snow condition being the single most important factor, (b) the abundance of animals near development areas where dogs are ranging, (c) fencing, and (d) other barriers. The major problem area can be described as a situation in which big game winter range abuts a developing area. In heavy snow, dogs can run on the top crust and easily chase down a deer which is breaking through the snow, especially if fences slow the deer's escape.

Dogs can and do cause problems with wildlife other than deer. Dogs have been observed killing ground-nesting birds in parks and wooded areas. (Beck 1973). In early April 1980 a pack of dogs killed three bighorn sheep near Montrose, CO, part of a new herd which had recently been transplanted to the area (Denver Post 1980). Also in Montrose County, an estimated $8,854 worth of livestock were killed primarily by dogs in 1979 (Hobden 1980). This is worth mentioning because ranchers may blame coyotes for damages done by free-ranging dogs.

INSTRUCTIONS FOR A DOG PREDATION IMPACT ASSESSMENT (Worksheet No. 8)

Estimating impacts from uncontrolled dogs in areas where development in big game winter range is occurring requires major assumptions on:

1. the number of dogs per human population in developing areas;

2. the percentage of dogs which are uncontrolled or free-running;

3. the zone of influence for predation by uncontrolled dogs;

4. the relationship between this zone and winter range; and

5. average annual mortality of animals in big game populations on winter range where uncontrolled dogs are present (mortality rates are a function of dog densities and big game densities in the conflict zone).

It is assumed that, while dog predation occurs throughout the year it becomes a significant problem only in situations where snow or some other barrier tends to trap the animals or greatly reduces their ability to escape. The conflict between uncontrolled dogs and concentrations of big game on winter range is becoming more common in winter recreation areas and near mountain home developments. It should be stressed that most uncontrolled dogs are owned dogs, not true strays or feral dogs, and that dogs which normally would not chase or assault wildlife may undergo a kind of metamorphosis when exposed to the psychology of the pack. Wildlife managers report it is often nearly impossible to convince owners that their dogs were captured chasing big game.

A suggested procedure to quantify losses of big game to uncontrolled dogs is presented in four steps:

109

Step 1 -   Estimating the number of new dogs entering the growth area

Step 2 -   Estimating the number of uncontrolled dogs

Step 3 -   Estimating the zone of influence of uncontrolled dogs and
           the average density of big game in that zone during critical
           winter months

Step 4 -   Estimating average winter mortality of big game as a function
           of dog densities and wildlife densities in the conflict zone

Representative data and an example Worksheet No. 8 are found in Section 11.

Step 1 - Estimating the Number of New Dogs Entering the Growth Area

Several general ratios on dog-to-human population have been suggested, including 1:2.8, 1:5.9, and 1:7 (Beck, 1973; Denney 1974). Allen and Westbrook (1979) estimated that 38 percent of all families own a dog, assuming a family size of 2.3. This suggests 1 dog/6 persons. Edwardson (1980) suggested that in cities under 2,500 households, 44 percent of the households had dogs; this percentage decreased to 33 percent in cities with 2,500 to 50,000 households. A ratio of 1:5 is suggested, based on conversations with the county clerk and local veterinarian in one impact area, Meeker, CO. Given this ratio and a selected target year, the number of dogs is estimated in Step 1 of Worksheet No. 8.

Step 2 - Estimating the Number of Uncontrolled Dogs

Denney (1974) suggested that one-third to one-half of the people who own dogs nationwide permit them to run free. In the rural Western States, this percentage is probably much higher, as there are few animal control laws in many communities and enforcement is less rigorous than in more urban areas. Therefore, Step 2 suggests that two-thirds of all dogs accompanying rapid growth development are uncontrolled.

Step 3 - Estimating the Zone of Influence of Uncontrolled Dogs and the Average Density of Big Game in that Zone During Critical Winter Months

This step requires an evaluation of the conditions in the study area likely to produce dog predation on big game. Using maps showing where community growth is expected to occur, problem areas should be flagged wherever new housing development will be within 6 mi of big game winter range. While the range of uncontrolled dogs is not documented, 10 mi is a reasonable maximum and 6 mi a reasonable estimate for a primary zone of influence around the perimeter of urbanizing areas. A circle with a 6-mi radius will equal about 113 mi^2. Another zone of greater or lesser radius can be drawn if local conditions, such as topography, create unique situations.

110

Where conflicts between winter range and dog range are apparent, the areas of conflict should be roughly measured. The average density of big game (winter period) in that zone should also be estimated.

Step 4 - Estimating Average Winter Mortality of Big Game as a Function of Dog Densities and Wildlife Densities in the Conflict Zone

The use of samples of low, medium, and high densities of uncontrolled dogs is suggested in Step 4 of the worksheet. Similarly, using varying densities of big game in conflict zones is suggested. A suggested value for average annual winter big game mortalities is determined by the inter-section of these animal densities. These relationships are preliminary. They were developed based on conversations with local animal control officers in problem areas and primarily reflect deer mortalities. These rates should be modified if site specific data are available or if experience in the specific area suggests other rates. They should also be modified to reflect rates of pronghorn losses if deemed significantly different.

If dog ranges conflict with nonwinter range, the analyst may wish to apply a similar procedure, but with reduced mortality factors (Step 4) based on available data and the experience of wildlife managers in the area.

Worscheet No. 8

DOG PREDATION IMPACT ASSESSMENT

Community _____

Species _____

Step 1 - Estimating the Number of New Dogs Entering the Growth Area

Population allocation for the
community (See Worksheet 1,
Step 5b)   = _____ ÷ 5 = _____ estimated additional dogs

Step 2 - Estimating the Number of Uncontrolled Dogs

        Estimated number   Estimated number of
        of dogs (Step 1)   uncontrolled dogs
        _____   x 0.67 =   _____

Step 3 - Estimating the Zone of Influence of Uncontrolled Dogs and the Average
         Density of Big Game in that Zone During Critical Winter Months

1. Map a primary zone of influence of uncontrolled dogs and calculate the
    area of the zone: _____ mi^2

2. Estimate the density of uncontrolled dogs in the primary zone of influ-
    ence:

                                                    Number of
        Number of   Square miles in   uncontrolled
        uncontrolled dogs   zone of influence   dogs/mi^2
        (Step 2)   (Line 1)   in primary zone

        _____   ÷   _____   =   _____

3. Map the overlap of big game range with the primary zone of influence
    and calculate the area of this conflict zone: _____ mi^2

4. Estimate the average density of big game on the winter range in the con-
    flict zone: _____ mi^2

112

<u>Step 4</u> - Estimating Average Winter Mortality of Big Game as a Function of Dog
Densities and Wildlife Densities in the Conflict Zone

Winter losses on winter range where predation by dogs will occur are
suggested below:

Number of uncontrolled dogs/mi² (Step 3, Line 2)	Winter mortality/mi² Number of big game/mi² (Step 3, Line 4)		
	< 10	10-50	> 50
0 - 0.1	0.03	0.04	0.05
0.1 - 0.4	0.06	0.07	0.08
0.5 and above	0.09	0.15	0.30

Average winter loss/mi² (above)		Area (mi²) in conflict zone (Step 3, Line 3)		Estimated average winter loss
_____	x	_____	=	_____

SECTION 8

WATER USE IMPACT ASSESSMENT

GUIDELINES FOR A WATER USE IMPACT ASSESSMENT

Water requirements for human use and community development are small in comparison with water requirements for an energy facility. Table 8 provides estimates of water requirements for new energy developments and the accompanying new population. However, human demographic impacts on water use are also significant.

Reservoir and hydropower projects may accompany regional development; such projects should be assessed very early to determine their potential for meeting local water demands while maintaining instream flow requirements critical to fisheries. Appendix J discusses resources for projecting future water demand as a function of human demographic trends. Also addressed is the problem of protecting instream flows where water resource development projects are proposed.

Regional development may stimulate more intensive agricultural use of land. Water supply problems can be compounded by irrigation demands because agriculture is a much greater user of water than most municipalities. Where agricultural use of land can be expected to increase due to regional growth and expansion, some agricultural practices can actually contribute to more water quality problems than a new energy industry, especially in terms of total dissolved solids.

In addition, where grazing use of rangeland increases with increased economic activity in a region, riparian areas will come under greater grazing pressure. Along many streams in arid regions, small stands of relict cottonwood and sycamore are the only forest vegetation remaining. As grazing pressure increases, primary productivity and biomass accumulation can decline along with structural complexity and abundance of wildlife dependent on the riparian ecosystems. Secondary effects of overgrazing include increased runoff and stream channel downcutting.

Woody riparian communities vulnerable to reservoir and hydropower projects as well as to increased agricultural use offer a variety of wildlife habitat values and are very critical where extensive forests are lacking. They may be the only available cover for some species. Trees and shrubs are required by most riparian bird species for roosting or foraging. Mammals depend on woody plant materials for shelter and as part of their diet. Humidity and shade are also attractive to some wildlife species. Dead woody vegetation can be used extensively by wildlife for nest sites, feeding, or perching.

114

Table 8. Energy activities and associated annual water requirements.

Activity	Water consumption (acre-ft/yr)
Coal-fired power plant (3000 MWe[a])	23,900-29,800
Surface coal mine (5 to 25 MMtpy[b])	100-1,240
Mine reclamation[c]	325
Coal gasification plant (250 MMscfd[d])	4,890-8,670
Coal liquefaction (100,000 bbl/day[e]	9,230-11,750
Tosco II oil shale (100,000 bbl/day)	12,900-18,600
Modified in situ oil shale (100,000 bbl/day)	7,600
Uranium mine and mills (1000 mtpy[f])	270-300
Slurry pipelines (25 MMtpy)[b]	13,500-18,400
Geothermal (100 MWe)[a]	12,700-13,700
Population growth (1,000 persons)	150-180 gpdc[g]

Source: Knapp and Leistritz 1978; Shupe 1978; Ballard et al. 1982.

[a] MWe = megawatt-electric
[b] MMtpy = million tons per year
[c] Irrigation for reclamation, assuming a 3-year reclamation period.
[d] MMscfd = million standard cubic feet per day
[e] bbl/day = barrels per day
[f] mtpy = metric tons per year
[g] gpdc = gallons per day per capita. About 180 gpdc translates to about 5 persons/acre-foot of water/yr.

The presence of surface water is a requirement for many wildlife species as an environment for feeding, reproduction, travel, and/or escape. The area of riparian vegetation within about 200 yd of a stream is the most heavily used by terrestrial wildlife.

Another potentially significant impact on water resources from urbanization is the dewatering of aquifers because springs, seeps, and associated riparian habitat are of critical value to wildlife. Water supply for small outlying communities usually comes from springs or wells; one rule of thumb for adequate well flow is 1,600 gal/day/connection.

Omitting obvious problems such as point source discharges and sewerline overflows, land use changes in urbanizing areas can affect stream quality by contributing to:

- increased storm water runoff which increases the frequency and severity of flooding, accelerates channel erosion, and alters stream bed composition;

- reduced base flow;

- alteration of the natural stream temperature regime;

- increased toxic substances such as heavy metals, pesticides, oil, road salt, and detergents;

- elevated nutrient inputs; and

- loss of riparian buffer strips needed to protect water quality and aquatic life.

The first environmental change in small streams during urbanization occurs with construction activities. Sediment from erosion on an acre of denuded ground may exceed by 20,000 to 40,000 times the amount of sediment eroded from agricultural lands over the same time period. Small watersheds that are being urbanized can generate nine times as much sediment as rural or natural drainage areas (Klein 1979). After construction may come an increase in storm water runoff due to increased imperviousness. Increased flood peaks during storm periods and decreased baseflows between storms are definitely related to increases in watershed imperviousness (Klein 1979).

By the time watershed imperviousness reaches 40 percent, a stream that had a bank-full flow once a year in its natural condition may have bank-full flows three times yearly. Increased flood frequencies strain the resiliency of the stream community, as young fish are eliminated by severe floods and invertebrate populations are severely damaged.

With more frequent flood frequencies also comes channel enlargement, primarily from bank erosion. This process introduces a high quantity of sediment into the stream and also makes it difficult for aquatic life to build stable populations. Debris dams (accumulations of logs, brush and litter) also become more frequent and limit the extent of the stream available to spawning fish. As baseflows diminish, the suitability of the stream for fish declines. Loss of cover, reduced velocities, temperature change, and impairment of movement over riffles are all associated with reduced baseflows. Conditions become serious when baseflows drop to 30 percent of the average, which can occur when 45 percent of the watershed is covered with impervious material (Klein 1979).

Detailed procedures to quantitatively determine the relationship be-
tween land use and water quality were reviewed by Hammer (1976), who focused
on the influence on water quality of unrecorded pollutant discharges from
developed and developing areas. Principal mechanisms of concern were wash-
off and erosion, unauthorized disposal of waste in surface waters and storm
sewers, contaminated groundwater (from septic systems, landfills, and sewer
leaks), overflow of municipal sewer systems, and hydrographic modification.
An important conclusion in this study was that small urban or urbanizing
basins appear to yield greater pollutant loadings per acre than larger
basins with similar land uses. The implication is that there is a tendency
for pollutants to settle out in stream channels, indicating a strong need
to consider potential problems created by deposited materials, problems such
as benthic oxygen demand and accumulation of toxicants in aquatic food chains.
The strongest socioeconomic explanatory variables for levels of most of the
water constituents studied were employment density and the percent of water-
shed land rendered impervious.

A problem of developing areas which deserves emphasis in rural western
communities is hydrographic modification. Construction of impervious sur-
faces increases storm runoff, which increases sediment production through
stream channel enlargement. Hydrographic modification also involves direct
alteration of stream channels as part of the land development process, which
disrupts aquatic habitats and increases discharge-related problems downstream.
The net effects can be more serious than the changes in water chemistry that
accompany urban development.

As a general rule, stream quality impairment is a function of the degree
to which a watershed becomes impervious. Generally, stream quality impair-
ment can be prevented if watershed imperviousness does not exceed 15 percent.
For more sensitive stream ecosystems, such as those supporting self-sustaining
trout populations, watershed imperviousness should not exceed 10 percent.
If new communities were to limit urbanization in undeveloped areas to these
guidelines, the degree of development should not exceed that shown in Table 9
(Schlosser and Karr 1981). In rural areas development would not usually
approach these levels, however. In such watersheds, efforts to protect water
quality should emphasize maintenance of riparian vegetation and stable flow
conditions.

In summary, the adverse impacts on water resources which can occur with
urbanization are the result of the interaction of many factors. Appendix J
discusses mitigation measures for some of these impacts. The worksheet which
follows addresses the questions of water supply and wastewater treatment
needs of new populations in rapid growth areas.

117

Table 9.   Recommended watershed development rates.

Land use category	Imperviousness %	Maximum amount of watershed that can be developed based on an imperviousness of	
		10%	15%
Individual homes			
0.40 ha (1.00 acre) lots	20	50	75
0.20 ha (0.50 acre) lots	25	40	60
0.13 ha (0.33 acre) lots	30	33	50
0.10 ha (0.25 acre) lots	38	26	29
0.05 ha (0.12 acre) lots	65	15	23
Townhouse/garden apartments	44	22	33
High-rise residential	56	18	27
Industrial districts	75	13	20
Commercial/business area	85	12	18
Shopping centers	95	11	16

Source: Klein (1979).

INSTRUCTIONS FOR A WATER USE IMPACT ASSESSMENT (Worksheet No. 9)

Worksheet No. 9 provides some guidance for resource managers concerned with increased water demand attributed to community expansion.   Potential need for additional wastewater treatment capacity is also addressed.   The worksheet is self-explanatory and includes the following steps:

Step 1 -   Determining need for water supply augmentation

Step 2 -   Identifying potential impacts where water supply is attributable to in-migrating population

Step 3 -   Determining need for wastewater treatment augmentation

Step 4 -   Identifying potential impacts where wastewater treatment augmentation is attributable to in-migrating population

Representative data and an example Worksheet No. 9 are found in Section 11.

Worksheet No. 9

WATER USE IMPACT ASSESSMENT

Step 1 - Determining Need for Water Supply Augmentation

Community: _____   Year:_____

1. Baseline population (Worksheet 1, Step 5d) = _____ persons

2. In-migrating population (Worksheet 1, Step 5d) = _____ persons

3. Total community population (lines 1 + 2) = _____ persons (Worksheet 1, Step 5d)

4. Planned capacity of water system in the evaluation year = _____ gpd

5. Baseline population need: $\dfrac{\rule{3cm}{0.4pt}}{(line\ 1)}$ x $\dfrac{(range)}{150\text{-}180}$ gpd $\dfrac{value}{\rule{1cm}{0.4pt}}$ = _____ gpd

6. Total population need: $\dfrac{\rule{3cm}{0.4pt}}{(line\ 3)}$ x $\dfrac{(range)}{150\text{-}180}$ gpd $\dfrac{value}{\rule{1cm}{0.4pt}}$ = _____ gpd

7. Compare planned capacity (line 4) to baseline population need (line 5): excess/deficit capacity without project-induced in-migration
    = (±) _____ gpd

8. Compare planned capacity (line 4) to total population need (line 6): excess/deficit capacity with in-migration
    = ± _____ gpd

    If the baseline situation projects a deficit, then the deficit with the in-migrating population can be assumed to be significantly greater and the assessment continues to Step 2. If deficits are to occur only with the in-migrating population, the assessment continues to Step 2. If there is no projected deficit in water supply with the projected in-migration, the conclusion can be reached that human demographic impacts on water supply will be negligible.

Step 2 - Identifying Potential Impacts Where Water Supply Augmentation Is Attributable to In-migrating Population

Community: _____   Year: _____

1. Identify probable source, location, size, and timing of additional water supply. Factors that dictate surface vs. ground water use are site-specific.

    Source(s):   _____
    Location: _____
    Additional capacity: _____
    Year available: _____
    Reservoir required?_____

119

2. Identify any potential adverse impacts to habitat values from increased use of identified source(s):

Terrestrial   Notes

Aquatic   Notes

3. Consider quantification of impacts where additional reservoir development is proposed; include habitat loss as a land use change in Worksheet No. 2, Land Use Impact Assessment.

Step 3 - Determining Need for Wastewater Treatment Augmentation

1. Baseline population (Worksheet 1, Step 5d) = _____ persons

2. In-migrating population (Worksheet 1, Step 5d) = _____ persons

3. Total community population (lines 1 + 2) = _____ persons (Worksheet 1, Step 5d)

4. Planned capacity of treatment system in the evaluation year = _____ gpd

5. Baseline population need: $\dfrac{}{(line\ 1)}$ x $\dfrac{(range)}{(40\text{-}230)}\dfrac{(value)}{(168)}\dfrac{\overset{std.}{value}}{}$ = _____ gpd

6. Total population need: $\dfrac{}{(line\ 3)}$ x $\dfrac{(range)}{(40\text{-}230)}\dfrac{(value)}{(168)}\dfrac{\overset{std.}{value}}{}$ = _____ gpd

7. Compare planned capacity (line 4) to baseline population need (line 5): excess/deficit capacity without project-induced in-migration = ($\pm$) _____ gpd

8. Compare planned capacity (line 4) to total population need (line 6): excess/deficit capacity with in-migration = ($\pm$) _____ gpd

    If no deficiency in secondary or tertiary treatment capacity is expected with the in-migration, the assessment can conclude that impacts from wastewater treatment augmentation will be negligible. If deficiency in treatment capacity will occur with the in-migrating population, continue the assessment to Step 4.

Step 4   Identifying Potential Impacts Where Wastewater Treatment Augmentation
          Is Attributable to In-migrating Population

Community: _____   Year: _____

1.   Identify probable type of wastewater treatment augmentation (septic tanks,
     secondary lagoon, or sewage treatment plant): _____

2.   Identify potential adverse impacts to habitat values if augmentation
     does not occur:

     Terrestrial   Notes

     Aquatic   Notes

3.   Where a secondary lagoon has been identified as the development option,
     consider including land use impacts (habitat loss from lagoon construc-
     tion) in Worksheet No. 2, Land Use Impact Assessment. For determining
     lagoon sizes, about 10 acres/1,000 people is considered average.

SECTION 9

ECONOMIC VALUE ASSESSMENT

GUIDELINES FOR AN ECONOMIC VALUE ASSESSMENT

The purpose of this section is to provide a procedure to place a dollar value on wildlife projected to be lost from human demographic impacts addressed in preceding sections. The assessment procedure has been limited to consider only recreational opportunities, or use-days, provided by wildlife. A number of other goods and services that may be supplied by wildlife habitat were omitted, such as urban green belt, floodwater retention, residential amenity values, research and education, cash crops, forage for livestock, windbreaks, wastewater assimilation, and ground water recharge. While these other goods and services are certainly not without value, it was felt that attempting to provide a procedure for such valuation was not feasible given the overall scope of this workbook.

In considering dollar estimating procedures for assessing recreational opportunities foregone, several factors must be acknowledged. The following constraints were pointed out by Jordan and Reinfeld (1982):

1. All existing techniques for estimating nonmarket values rely on assumptions and approximations that are vulnerable to criticism and dispute.

2. The more defensible an approach is, the more difficult, time consuming, and expensive it tends to be.

3. Given the time, expense, and expertise needed and the difficulty of validating results, it may not often be seen as cost-effective (or even possible) to undertake the analysis.

4. Managers in need of dollar estimates of nonmarket value have had little basis for choosing among the available techniques. The state of the art is not widely understood, and access to economic expertise is unevenly distributed.

Finally, because requirements for human demographic impact assessments do not exist, let alone monetary valuation of projected wildlife losses, unless the user (resource manager or planner) perceives a personal need for such information as a decisionmaking tool, he or she is unlikely to authorize the expenditure of scarce resources to acquire it.

The procedures available for estimating values of wildlife-related recreation are generally those that rely on (a) market data and (b) values expressed by people asked outright how much they hypothetically would be willing to pay for a given experience. Market techniques utilize relationships between a level of recreation use and user purchase of market goods which can be priced. From the known price, an estimate of value for the nonmarket good, recreation, is derived. For example, if elk hunting were the nonmarket good, the hunter's expenditures for the hunting trip could be used to estimate the nonmarket value of the elk hunting experience. The second type of procedure, which relies on expressed values, is called the contingent valuation (CV) method because it asks people how much they would value a resource in a particular contingency.

Both a market technique (in this case, a travel cost method) and a contingent valuation method were considered for inclusion in this workbook. The travel cost method (TCM) uses a sum of travel expenditures and the value of travelers' time as a proxy price of visiting a particular recreation site. These travel costs are combined in a model with other factors, such as social/economic characteristics of site users, availability of substitute sites, use fees, and site quality considerations, to generate a demand curve. From the demand curve the value of the recreation experience can be calculated. However, certain conditions must be met if the travel cost method is to be used in energy impact studies. One requirement of the approach is the need for a relatively large number of visitors from a wide variety of distances. A second requirement is that access to the area or opportunity to be evaluated be relatively restricted so that visitors can be easily counted. However, energy impact areas are typically counties, with recreation, especially hunting, occuring almost all over the area. Furthermore, most recreationists are also local residents. For these reasons, the travel cost technique may be less frequently used for energy impact studies.

The CV method has been identified by many recreation economists as being extremely useful (Jordan and Reinfeld 1982). At the same time it requires very good data and high skills for its application. It also requires very carefully constructed surveys so as not to introduce bias or game playing by respondents. Such surveys may be far too expensive and time consuming for resource managers to consider.

A variant procedure which may hold promise in the future is called the "hedonic travel cost approach" (Brown and Mendelsohn 1980). Data to implement this approach were theoretically built into the 1980 National survey (U.S. Department of the Interior and U.S. Department of Commerce 1982). The analysis produces a demand curve and an estimate of value for a particular attribute of wildlife-related recreation, rather than for a specific place. With further development this approach may offer the important advantage of using data nationally compiled and available by State.

The least technical but most often used approach for estimating value of wildlife-related recreation is the unit day value (UDV) method. The U.S. Forest Service uses unit day values (or ranges of values) adjusted on a regional basis. By 1990 the U.S. Forest Service hopes to have unit day values based on regional travel cost models. The values currently in use by the U.S. Forest Service were derived from the judgments of expert committees, from extrapolations of studies reported in the literature, and from special studies.

The UDV approach is certainly the most convenient. It can also be argued that values based on expert judgment are as valid as those derived from elaborate approaches, considering the conceptual and practical problems the latter methods encounter. However, unit day values tend to underestimate resource values.

Having reviewed the most probable alternatives, it was decided to include information pertinent to both the CV and UDV methods in this workbook. Appendix K provides guidance on the preparation of surveys for a CV method in the event that funds, expertise, and time allow this more sophisticated technique to be used to generate use-day values. Worksheet No. 10 can use any use-day value but the sample values are based on UDV values reported in the literature. These sample unit day values were derived from studies that assigned willingness to pay values to user days for consumptive use of several of the species used for evaluation in the worksheets in previous sections of this workbook. Appendix L discusses an approach to modifying the sample unit day values based on an impact area's unique characteristics.

Worksheet No. 10 also addresses valuation of projected losses in use-days for nonconsumptive wildlife-related recreation, where these losses have been identified as impacts on public use areas previously available for use in observing or photographing wildlife.

The worksheet does not aggregate impacts over the project life because it is designed to be used with the entire set of worksheets on the basis of a selected evaluation year. The FWS Human Use and Economic Evaluation procedures (104 ESM) may be used to aggregate impacts over the project life, taking account of changes occurring between years for which data are estimated. Discounting procedures also are provided in 104 ESM (U.S. Fish and Wildlife Service 1980b).

INSTRUCTIONS FOR AN ECONOMIC VALUE ASSESSMENT (Worksheet No. 10)

The six steps presented in the procedure are:

Step 1 - Summarizing wildlife losses from land use conversions

Step 2 - Summarizing wildlife losses from other impacts

Step 3 - Summarizing all losses and estimating hunting and fishing use-days foregone

Step 4 - Estimating values of hunting and fishing use-days foregone

Step 5 -   Estimating value of other wildlife-related recreation
use-days foregone

Step 6 -   Summarizing value foregone

An example Worksheet No. 10 is included in Section 11.

Step 1 - Summarizing Wildlife Losses from Land Use Conversions

Worksheet No. 10 suggests a species list based on those species for
which average values of willingness-to-pay per day of hunting or fishing
use were obtained from a recent, detailed literature review. Step 1 facili-
tates listing wildlife losses for the evaluation year based on the species
evaluated in Worksheet No. 2, the Land Use Impact Assessment.

Step 2 - Summarizing Wildlife Losses from Other Impacts

Impacts quantified in Worksheets Nos. 5, 6, 7, or 8 (ORV or snowmobile
use, poaching, road kills, and dog predation) are entered in this step. An
"other" category is provided for any additional human demographic impacts
for which wildlife losses may have been quantified by the user (e.g., sand
and gravel operations which will eliminate a section of stream or river).

Step 3 -   Summarizing All Losses and Estimating Hunting and Fishing Use-Days
Foregone

Line 1 - Subtotals are entered from Steps 1 and 2.

Line 2 - Total is entered.

Line 3 - Average use-days per kill or catch are entered. Data for
species that require less than 1 day to kill or catch are entered
as fractions, e.g., 0.25 use-days for trout if a catch of 4 trout/
day were the average for the impact area. These data should be
available from State game and fish departments.

Line 4 - Calculate as shown.

Step 4 - Estimating Values of Hunting and Fishing Use-Days Foregone

Line 1 - Use-days are entered from Step 3, Line 4.

Line 2 - Sample use-day values, as found in a detailed literature re-
view are given. The user can also review Appendices K and L when
selecting an approach to generating use-day values using either a
contingent valuation approach or a modified unit day value.

Line 3 - Calculate as shown.

Step 5 - Estimating Value of Other Wildlife-Related Recreation Use-Days Foregone

Line 1 - Identify any public use area which will be reduced in recreational carrying capacity as a result of the proposed project, i.e., land will be lost to recreational use.

Line 2 - Estimate use-days foregone. For example, if a natural area which previously sustained 1,000 use-days/year is lost to urban development, 1,000 use-days would be entered. The user will need to consult local recreation planners, conservation organizations (such as Audubon Society members), and the land owner (or public agency) to generate these estimates.

Line 3 - Select a value or enter a site-specific value if data are available.

Lines 4 and 5 - Calculate as shown.

Step 6 - Summarizing Value Foregone

Calculate as shown.

Worsheet No. 10

ECONOMIC VALUE ASSESSMENT

Step 1 - Summarizing Wildlife Losses from Land Use Conversions

County/impact area _____

Year ____

	Central site	Sphere of influence area	Utility	Road or rail	Reservoir	Other	Total
Big game							
Deer							
Elk							
Pronghorn							
Bighorn sheep							
Other:							
_____							
Upland game/small game							
Pheasant							
Turkey							
Mourning dove							
Other upland birds:							
_____							
_____							
Total							
Small game mammals							
Waterfowl							
Predators							
Fish							
Bass							
Trout and coho							
Pike and walleye							
Catfish							
Panfish:							
warmwater							
coldwater							
Freshwater, general							

Step 2 - Summarizing Wildlife Losses from Other Impacts

	Use area (Worksheet No. 5)		Poaching (Worksheet No. 6)	Road kill (Worksheet No. 7)	Predation (Worksheet No. 8)	Other	Total
	ORV	Snowmobile					
Big game							
Deer	___	___	___	___	___	___	___
Elk	___	___	___	___	___	___	___
Pronghorn	___	___	___	___	___	___	___
Bighorn sheep	___	___	___	___	___	___	___
Other: ___	___	___	___	___	___	___	___
Upland game/small game							
Pheasant	___	___	___	___	___	___	___
Turkey	___	___	___	___	___	___	___
Mourning dove	___	___	___	___	___	___	___
Other upland birds:							
___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___
Total	___	___	___	___	___	___	___
Small game mammals	___	___	___	___	___	___	___
Waterfowl	___	___	___	___	___	___	___
Predators	___	___	___	___	___	___	___
Fish							
Bass	___	___	___	___	___	___	___
Trout and coho	___	___	___	___	___	___	___
Pike and walleye	___	___	___	___	___	___	___
Catfish	___	___	___	___	___	___	___
Panfish:							
warmwater	___	___	___	___	___	___	___
coldwater	___	___	___	___	___	___	___
Freshwater, general	___	___	___	___	___	___	___

Step 3 - Summarizing All Losses and Estimating Hunting and Fishing Use-Days Foregone

	1. Subtotals		2.	3. Average use-days per kill or catch	4. Use-days foregone (Line 2 x Line 3)
	Step 1	Step 2	Total		
Big game					
Deer	___	___	___	_____	_____
Elk	___	___	___	_____	_____
Pronghorn	___	___	___	_____	_____
Bighorn sheep	___	___	___	_____	_____
Other:_____	___	___	___	_____	_____
Upland game/small game					
Pheasant	___	___	___	_____	_____
Turkey	___	___	___	_____	_____
Mourning dove	___	___	___	_____	_____
Other upland birds:	___	___	___	_____	_____
_____	___	___	___	_____	_____
	___	___	___	_____	_____
Total	___	___	___	_____	_____
Small game mammals	___	___	___	_____	_____
Waterfowl	___	___	___	_____	_____
Predators	___	___	___	_____	_____
Fish					
Bass	___	___	___	_____	_____
Trout and coho	___	___	___	_____	_____
Pike and walleye	___	___	___	_____	_____
Catfish	___	___	___	_____	_____
Panfish: warmwater	___	___	___	_____	_____
coldwater	___	___	___	_____	_____
Freshwater, general	___	___	___	_____	_____

<u>Step 4</u> - Estimating Values of Hunting and Fishing Use-Days Foregone

	1. Hunting and fishing use-days foregone (Step 3, Line 4)	2. Value per use-day ^{a} Sample value	Value ^{b}	3. Value foregone (Line 1 x Line 2)
<u>Big game</u>				
Deer		$52.62		
Elk		43.59		
Pronghorn		19.70		
Bighorn sheep		12.77		
Other: _____				
Big game general		76.95		
Upland game/small game				
Pheasant		65.07		
Turkey		35.86		
Mourning dove		41.24		
Other: _____				
Total		43.03		
Small game mammals		20.48		
Small game, general		39.60		
<u>Waterfowl</u>				
Ducks		55.05		
Geese		7.03		
Waterfowl, general		40.29		
<u>Predators</u>		24.98		
<u>Fish</u>				
Bass		34.07		
Trout and coho		16.69		
Pike and walleye		53.60		
Catfish		22.72		
Panfish:				
warmwater		54.05		
coldwater		29.37		
Freshwater, general		19.75		
		4. Subtotal		

---
a See Appendix L for modification of sample use-day values.
b Enter own value but give rationale on the worksheet.

130

Step 5 - Estimating Value of Other Wildlife-Related Recreation Use-Days
         Foregone

1. Use areas	2. Use-days foregone	3. Value per use-day Sample value[a]	Value	4. Value foregone (Line 2 x Line 3)
_____	_____	$14.87	____	_____
_____	_____	_____	____	_____
_____	_____	_____	____	_____
			5. Total	_____

_____

[a] See Appendix L.

Step 6 - Summarizing Value Foregone

    Subtotal (Step 4, Line 4) _____
    Subtotal (Step 5, Line 4) _____
              Total   _____

131

SECTION 10

MITIGATION OF HUMAN DEMOGRAPHIC IMPACTS ON WILDLIFE

In several respects, human demographic impacts are difficult to mitigate. First, there are few legal or regulatory requirements for such impact mitigation, which is in contrast with the regulations that energy companies face in direct, site-specific mine operations (e.g., reclamation and pollution control). If a developer proposes a housing subdivision on private land in key winter range, usually no legal basis exists for requiring impact mitigation. Secondly, human demographic impacts can be very widely dispersed. For example, increased demand for hunting may be distributed across a multi-county area. Third, these impacts are often not visible and, therefore, are difficult to demonstrate to local decisionmakers. An example is the impact on wildlife from human presence in a previously remote area; even experts disagree as to the real impact of human presence and the extent to which wildlife can adapt to various levels of intrusion by people and machinery. Fourth, little past research on environmental impacts has focused on human demographic impacts. The state of the art of quantifying many human demographic impacts in terms of animal behavior or habitat loss has far to go before resource managers can confidently predict impacts and identify the mitigation actions that most benefit the targeted wildlife or fisheries population.

Regardless of the difficulties outlined above, a framework does exist for addressing mitigation appropriate to human demographic impacts. A traditional and useful approach is to enhance habitat on other lands to compensate for land use conversion, habitat degradation, and human activity impacts. Appendix I provides information on this broad subject. This section addresses two other approaches to mitigation:

. prevention of adverse effects from land conversion and habitat loss or degradation; and

. reducing or avoiding adverse impacts of human activities.

Of course, policies of participating Federal and State agencies should be followed in any impact mitigation plan.

PREVENTION OF ADVERSE IMPACTS FROM LAND CONSERVATION AND HABITAT LOSS OR DEGRADATION

Mitigation Measures

The ideal mitigation plan would constitute a series of measures that equal the replacement value of the losses in the resource base, losses attributable to land conversion and other impacts. The best time to begin mitigation for growth areas is very early in the planning process. When resource professionals are involved in the earliest stages of the planning that accompanies local growth, impacts can be projected, mitigation potentials identified, and mitigation practices included in the growth plans. This approach is economically more advantageous than using mitigation to reduce already existing problem situations because measures to reduce potential adverse impacts to fish and wildlife habitats are typically less costly than remedial actions taken after adverse impacts have occurred. Also, timely mitigation planning will be less costly in terms of time because, in contrast to revising plans and schedules to develop and implement mitigation measures, early planning to maintain fish and wildlife values can keep other development on schedule. The key is to become involved early in the planning process. Appendix A offers guidelines to resource managers for planning entry points.

Five mitigation measures discussed in this section are:

1. constraining growth in high value habitat areas;
2. use of energy impact funds;
3. alternatives to land acquisition;
4. nontraditional industry assistance; and
5. education programs.

This section is a "menu" of mitigation alternatives, not a recommended step-by-step procedure. Critical questions remain unanswered on equating each mitigation measure to potential gains or savings in wildlife resources. The state of the art of demographic impact assessment and mitigation is too preliminary to provide formulas for such a balance sheet approach. In the future, as mitigation approaches are tested in rapid growth areas, guidance on evaluating some of the approaches may be forthcoming.

Constraining growth in high value habitat areas. Some counties and States have made progress in incorporating fish and wildlife concerns into local planning and land use decisionmaking. Two examples are Natrona County in Wyoming and Gunnison County in Colorado. Natrona County has drafted a zoning resolution that proposes a constraint map to take wildlife habitat into consideration and requires consultation with the Wyoming Game and Fish Department when development is proposed that affects such areas. Gunnison County has a land use resolution that includes guidelines for wildlife resource areas. Their purpose is to "aid in the protection and preservation of significant wildlife habitats and species of wildlife in Gunnison County." Anyone desiring to make a land use change within a significant wildlife habitat (habitat that, when lost, would eliminate a species or cause a species

133

to become endangered) is required to consult with the Colorado Division of Wildlife and to submit detailed information on the proposal (Gunnison Board of County Commissioners 1977).

The Wyoming State Land Use Plan, developed in 1979, was an attempt to establish general guidelines that all local governments could use for planning purposes. State policy included recommendation for a coordinated effort among local planning entities and State and Federal agencies responsible for land management decisions involving agriculture, recreation, and wildlife management. The recommendations also urged local jurisdictions to define agricultural-rural lands; require public meetings whenever development was proposed on such lands; restrict flood plain lands from development; require developers to absorb all costs related to conversion of such lands for nonagricultural purposes; and implement performance standards, permit systems, easement purchase, and other mechanisms as alternatives to traditional zoning.

In North Dakota, a 1978 report prepared by the State Planning Division recommended the following (North Dakota State Planning Division 1978):

- legislation establishing minimum uniform comprehensive land use planning requirements for all units of government with land use responsibility;

- legislation establishing statewide rural subdivision ordinance requirements and resources to implement such ordinances;

- legislation that establishes a process for the nomination, designation, and management of resource areas of greater than local concern;

- providing materials and speakers on land use planning for programs for all service clubs, professional and farm organizations, and high school science classes in the State;

- providing a series of regional public forums or workshops to propose programs for achieving land use and natural resource objectives, and a State forum to make recommendations to the executive and legislative branches;

- preparing a 1-hour TV production on economic growth, the environment, and other issues;

- working toward a comprehensive land use information system; and

- protecting scenic open spaces and other land especially suited for recreation and aesthetic enjoyment.

It was recommended by participants in State and regional public meetings that a coordinated review of any projects of State interest include (a) fish and wildlife resources conservation and (b) consideration of natural and wildlife areas. Projects of State interest might include:

134

- major airports;

- major systems of solid or liquid waste collection, treatment, or disposal;

- major energy facilities;

- major recreational development;

- transportation systems or facilities of regional or State concern;

- major water storage and distribution systems;

- major basic industrial, commercial, and agricultural development; and

- major public service facilities serving regional or State populations.

It was also recommended that State and local planning bodies consider, in land use plans, the cumulative impact on fish and wildlife resources of all proposed or potential developments within an area. Containment of urbanization within existing service areas or designated growth areas was encouraged, and extension of facilities and services outside existing service areas was discouraged unless all urban facilities appropriate to that area were planned for development (North Dakota State Planning Division 1978).

The human settlement policy of the State of Colorado seeks to discourage development that would jeopardize significant wildlife habitats. The State specifically attempts to foster patterns of development which are clustered and compact, within existing communities or contiguous to built-up communities, and that maximize use of existing infrastructure. Patterns of diffused, low density development, strip or corridor development, and leapfrog development are to be avoided. Significant wildlife habitats are defined through State legislation. A special effort is to be made to consider the impacts on wildlife of proposed projects located in riparian areas and flood plains, shorelands of lakes and reservoirs, wetlands, mountain slopes with south- and southwesterly exposures below 9,000 ft elevation and adjacent valley floors, and habitats of threatened and endangered species, as listed by State and Federal Governments. It is recognized that some losses in the resource base will be unavoidable as communities expand, but that, if community expansion is consistent with the patterns identified above, these losses will be kept as low as possible. The State gives priority to development complying with these policies where cases of conflict with wildlife habitat occur (Colorado Department of Local Affairs 1979).

Other alternatives for municipalities and counties include using contract or conditional zoning to recognize the competing interests between a developer and the public's concern for wildlife values. As a condition for rezoning, the controlling public body could require concessions from the developer not normally required; for example, habitat enhancement on remaining open space under the developer's ownership.

135

Growth and land use policies may be most workable when tied to sewerage policies. Seven alternative policies are listed below, along with the mechanisms for their accomplishment.

Policy	Principal mechanisms
Sewer moratorium	Ban or quota on new sewers, connections, building permits, subdivision approval, rezoning
Refusal to sewer	Rural fringe and community refuses to provide sewerages
NEPA review	Mandatory agency and public review of Federally funded projects to encourage consideration of secondary impacts
Facility design	Select physical options that encourage certain types of land use; e.g., force mains, smaller treatment plants
Facility sizing	Limit capacity in projects to preserve future land use options
Service area	Establish "urban service area" within which public services will be provided
Staging area policy	Staging of individual facilities that promote certain development patterns

Finally, local procedures for subdivision approval should involve State game and fish departments in the review process. It works best when submittal to the state game and fish department occurs at the "sketch plat" phase, or the earliest phases of developer interest. Natural resource specialists then have the opportunity to make recommendations on the proposed land use change based on considerations of impacts to fish and wildlife resources.

Use of energy impact funds. In North Dakota, coal severance taxes and State general revenues contribute approximately equally to the current 2-year appropriation ($22 million) for the State's Energy Impact Office. The primary thrust of this office insofar as wildlife mitigation is concerned is to support mine land reclamation research and to improve the legislative framework in which reclamation decisions are made. Reclamation legislation currently directs companies to return all mined land to suitability for previous use (primarily grazing) or higher use. Benefits to wildlife would occur if the legislation instead encouraged reclamation on portions of land to higher economic use (e.g., cropland) and dedication of other parcels strictly to use by the State Department of Game and Fish. The Energy Impact Office is working for these legislative changes.

136

Energy impact funds could be required in all energy development areas for mitigation measures to compensate for unavoidable adverse human demographic impacts. Options include:

- replacement of takings with protected areas;
- use of scenic easements to protect habitat;
- control of wildlife access to potential road kill areas;
- planting and seeding for wildlife habitat;
- creation of new water sources for wildlife;
- construction of wildlife shelters; and
- a maintenance program for vegetation.

Some precedent for use of energy impact funds to improve wildlife-associated recreational opportunities for counties impacted by rapid growth exists. In North Dakota's Energy Impact Office, energy impact funds have gone to local park districts to assist in developing additional boat ramps on Lake Sakakawea in Mercer County. The funds are part of an agreement between the U.S. Army Corps of Engineers and the park districts of two cities to mitigate impacts of increased fishing pressure on this major fishing lake.

If city and county officials were to express concern for mitigation of impacts on wildlife and improved wildlife-associated recreation opportunities, there appears to be no reason why energy impact funds could not or would not be used in the future to assist in specific proposals. But this will require information on: (a) the nature and extent of human demographic impacts on wildlife; (b) the relationship between such impacts and declining quality recreational experiences for old as well as new residents of the area; and (c) the options for mitigation and habitat enhancement. Progress toward mitigation of human demographic impacts will depend heavily on the coordinated efforts of natural resource specialists, planning professionals, and public and private interests.

Other funding strategies can be considered, including a county sales tax applied to conservation and natural resource management and initiation of an energy trust fund for similar purposes.

Alternatives to land acquisition. Financial and political constraints to land acquisition may lead to the exploration of other approaches to protecting fish and wildlife values. One approach is to form partnerships among Federal, State, and local governments and the private sector to protect wildlife resources of importance with whatever tool is most appropriate in a given case. Some possible wildlife resource management tools include:

1. Public education and awareness approaches could be used to promote private landowner stewardship. There could be a "National Wildlife Habitat Program," similar to the National Natural Landmarks Program, to encourage and publicly recognize landowners for voluntarily managing their land for wildlife resources.

2. Land use options could be avoided that might indirectly adversely affect high value wildlife habitat unless no prudent or feasible alternative exists.

137

3.   Regulatory controls could be strengthened, including variations in zoning (such as agricultural districts), planned unit developments, and sediment control regulations. Unsuitability criteria could be applied to planning and zoning procedures in rural areas. Wildlife habitat designations of critical or high value, made by county governments, could be used in land use trade-offs. For example, landowners could be asked to enhance habitat in some areas (or increase access to private lands for hunting or other activities locally in short supply) in return for being allowed to make land use conversions in other areas.

4.   Lands could be partially, rather than totally, acquired. Acquiring the development interest or an easement to timber, water, minerals, grazing, or other rights may be all that is needed to secure a habitat for wildlife. A public right to access might also be purchased. Land can be purchased with reserved interests, such as a life tenancy for the previous owner. Land can also be purchased and resold or leased back to private parties with restrictions in the deed as to its use.

5.   The tax benefits of donating all or part of a parcel of land, selling it below market value, or making a gift of the land with life tenancy included could be publicized.

6.   Donations of easements needed for better habitat management could be encouraged.

7.   Public land could be traded for private land in order to obtain key areas. For example, preserving key blocks of habitat may make it possible for herds to regroup following disturbance in traditional winter range due to large-scale development.

8.   Liaisons with landowners or developers could be formed in order to maintain habitat in a manner that will maximize wildlife populations. For example, if development is proposed in a forested area, large-scale clearing can be avoided and as many trees as possible left to provide habitat. Some developments can accommodate strips or blocks of trees within the development area. Providing firewood at reasonable cost on either public or private land can mitigate some of the negative effects of indiscriminate firewood gathering. In some cases wildlife can benefit from planned firewood gathering; e.g., aspen resprouting to form a young stand of trees.

9.   Private conservation organizations could play an effective management role where habitat that is optimum for certain species is in private ownership. For example, the purchase of key parcels of land that would meet habitat requirements for local populations of interest should be considered. Also, conservation groups may be more successful than government agencies in persuading business or industry representatives in some areas to adopt management practices designed to protect wildlife.

Nontraditional industry assistance. Precedents are growing for a stronger role by industry in impact mitigation. Recently, negotiations among the Overthrust Industrial Association (OIA), which represents 37 energy firms,

the National and the Wyoming Wildlife Federations, the U.S. Bureau of Land Management, and the State of Wyoming, resulted in an agreement to conduct a 3-yr, $800,000 wildlife study, funded by the OIA. The study is intended to assist industry planners and environmental specialists by recommending cost-effective ways to lessen the impacts of human activity on wildlife in the Overthrust Belt. In addition to the wildlife study, the OIA agreed to provide $40,000 for an environmental awareness study designed to alert the public to the responsibilities and ethics involved in wildlife-related recreation in the area. The Wyoming Game and Fish Department will receive $80,000, and the Utah and Idaho Fish and Wildlife Departments $40,000 each, to fund hiring of enforcement officers to reduce poaching in the area.

Tax incentives could be used effectively with the private sector, with resultant payoffs for wildlife. Company holdings in land could be dedicated, all or in part, to wildlife propagation. For example, when a company buys land that it would otherwise lease for grazing, part or all of the land could be set aside for wildlife use. Corporations often respond to public beliefs that wildlife is important and that wildlife needs should be considered. Corporate interests can be encouraged to take a more active role in meeting additional demands on the resource base and also in preventing unnecessary losses of animal populations or habitats.

Educational programs. The Utah Division of Wildlife Resources, in cooperation with the Plateau Mining Company, provides an educational program for new workers coming into an energy impact region. This 35-mm slide-tape training presentation is widely used within Utah's coal industry. The training program has become part of a preemployment mining course attended by all prospective coal mining employees. The training program has also been implemented in other Western States, as well as within noncoal industries in Utah. The basic theme of the program is that "wildlife have a place living with the human race." The program identifies the diversity of the local wildlife resource and environmental laws relevant to coal mining and wildlife. It suggests how the company and its employees can work together to protect wildlife and their habitats. Industries utilizing the training program have expressed satisfaction with the product and the favorable response of their employees.

Another alternative is to develop short courses on planning for environmental quality that can be presented to individuals serving on planning commissions and any other interested persons. These courses could feature speakers with working experience in planning, wildlife management, and community involvement. The short course could be supplemented with written material, such as a short course manual, maps of high value habitat in the county, and a glossary.

Wildlife agencies can effectively involve the public in their planning process. The planning objectives that are established can be used in evaluating potential impacts of development. With adequate involvement, the public will have a vested interest in meeting wildlife objectives.

Recognizing that instream flows are a valid beneficial use of water can become a public education goal. Promoting a change in the law if a State currently does not recognize instream flow as a beneficial use is an essential step toward the possibility of purchasing water rights for fish and wildlife interests.

General Recommendations for Mitigation

Including fish and wildlife concerns in the local decisionmaking process. Land development and land use decisionmaking are continuing processes in growth regions. Land use decisions are made every month by local government authorities. Yet local governments may have little access to the opinions of wildlife experts nor do they usually have the expertise for devising engineering and mitigation strategies. They rely on experts from State and Federal agencies and consulting firms and on local people who are knowledgeable. Even in counties where wildlife preservation has a high economic or quality of life value, local governments may not actively seek information about fish and wildlife protection and management.

Fish and wildlife information must be entered into the process at the proper time and in a useful format in order to be considered and made a part of the general planning framework. It must be timely, understandable to lay persons, and relevant to the decisions that must be made. Resource professionals should strive to:

1.   provide continuing education and information about fish and wildlife concerns; e.g., key habitat areas, potential losses, and monetary values, to newly elected officials and to new personnel in advisory or administrative positions in local government agencies that deal with development decisions;

2.   provide technical assistance to local government officials, consulting engineers, planners, and private developers in advance of formal plan preparation;

3.   attend meetings where major developments are being planned or major changes in local government policies are being considered;

4.   review and comment on plans, policies, and regulations developed by county and municipal governments that will result in land use conversions that will impact fish and wildlife resources; and

5.   encourage education, information, and technical exchange among State and Federal agency personnel regarding fish and wildlife concerns when growth-shaping projects are under consideration.

Technical assistance for mitigation. Maps are one of the most useful tools that local officials and planners can have when making land use decisions. Ideally, maps should be separate from reports and made on a reasonably large scale. Scales that are compatible with local and county plans

140

are best. (Many maps showing wildlife and environmental matters are con-
tained in environmental studies, but they are often on too small a scale to
be useful to planners.) If a great deal of information must be shown about
an area, overlays or multiple maps are desirable. Local government staffs
may need to rely on Federal and State agencies for the necessary maps. Even
very rough maps can be useful. Furthermore, new personnel will need to be
briefed on the maps and information available, as well as significant issues
for fish and wildlife in that area and region. Maps should be kept updated
and should include:

- areas of greatest population impact, in terms of land use conver-
  sion and the probable locations of dispersed development and human
  activities;

- critical fish and wildlife habitat, shown in the context of a popu-
  lation unit with emphasis on potential conflicts;

- private and public lands; and

- jurisdictional boundaries of each government entity with decision-
  making power within the conflict areas.

Such maps should be accompanied by information on significant or crit-
ical wildlife zones and the relative importance of protection within the
various wildlife zones on a regional basis. Quantitative information can
be included pertaining to the goal of protecting a certain number of animals;
economic information can be included on how much habitat is necessary to
conserve the recreation portion of the regional economy. Information about
endangered or threatened species should also be included.

Regional maps are essential in order for local governments to coordinate
their decisions and planning. These maps are also necessary for siting linear
facilities that cross jurisdictional lines. Regional maps should designate:

- key habitat areas, including riparian areas, winter range, yearlong
  or summer range, breeding or nesting areas for important species,
  and courtship areas;

- migration routes;

- sites where new access into previously remote areas will disturb
  local populations of animals;

- significant and critical water management areas, including water-
  sheds, stream and wetlands protection needs, surface water recharge
  areas, and aquifer recharge areas;

- known locations of heavy recreational use;

- areas where recreational activities should be limited;

- sites of probable recreation vehicle problems;

- locations of all roads (including dirt roads and trails) and linear facilities, such as transmission lines;

- sites of probable road kill problems; and

- habitat of any threatened or endangered species.

Useful information that could accompany each regional map includes:

- projected consumptive and nonconsumptive demands for fish and wildlife by in-migrating populations;

- explanations of why certain areas are critical or require protection;

- quantification of potential fish and wildlife losses if land uses change;

- information about road traffic, road kills, and negative impacts on ecosystems from recreation (intensive or dispersed uses) within the area;

- quantification of losses of animals from illegal human activities in the study area; and

- monetary values of potential resource losses.

For communities that will undergo significant growth, maps of the municipality and its sphere of influence should include:

- any significant or critical wildlife areas;

- significant stream protection or watershed protection areas;

- information useful for evaluating sites for location of municipal facilities, linear facilities, recreation areas, and housing; and

- information useful for evaluating the relative regional importance of wildlife protection within the sphere of influence of towns.

Human demographic impact mitigation plan. This workbook suggests a format by which resource planners can compile impact information and organize an effective and coherent human demographic impact mitigation plan. Until mandatory consideration of wildlife resource needs are incorporated into the responsibilities of county and State planning boards and commissions, mitigation of human demographic impacts through stipulation within permits is not likely to occur.

142

A recommended and coordinated mitigation plan should include:

1.   rationale for wildlife and fishery priorities;

2.   rationale for projected human population growth and location;

3.   designation of areas unsuitable for development;

4.   designation of preferred development areas; and

5.   trade-off plans for areas with high wildlife priority and high development potential, including recommendations, where necessary, for off-site mitigation and habitat enhancement.

One approach to preparing such a plan for guiding development and human activity is through public hearings and assistance in the drafting and implementing of county plans. Major landowners and industry representatives should be involved from the outset in preparation of the plan. One impact that should be stressed in this approach is that more intensive and expensive wildlife management will be required as a result of growth.

Local officials in growth areas should be encouraged to initiate memoranda of agreement for cooperation between all levels of government and with the private sector. One such agreement has been initiated in Garfield and Mesa Counties in Colorado. There, Federal, State, and county representatives are drafting an area plan that focuses on transportation, recreation, and wildlife values, key elements in the management of human demographic impacts. The plan will incorporate the resource management plans of the two Federal agencies with primary responsibility for public lands in the Battlement Mesa area (the U.S. Forest Service and the U.S. Bureau of Land Management) and the goals of the Colorado Division of Wildlife. County commissioners are interested in furthering the Federal and State goals; it is hoped that private industry and landowners will be receptive to the recommendations, because the plan also includes privately owned lands.

There should be a research and reporting element in any such plan. One key to successful mitigation lies in obtaining valid baseline information, followed by periodic monitoring studies that at least identify trends in wildlife populations and attribute them to extrinsic environmental factors. Limitations associated with obtaining adequate baseline information cannot be overemphasized, because constraints in available time and personal resources usually exist. Even when adequate resource data are available, obtaining support to act on the monitoring information may be a considerable obstacle, and regulatory and enforcement components of the plan may become critical.

A recommended mitigation plan should include the following items:

1.   identification of specific sections of land where limitations on use would be advisable;

2. definition of limitations or protection measures that should be included in the local land management policies;

3. evaluation of the impacts on wildlife of alternative sites or corridors;

4. strategies, technical or engineering measures, or land management practices that can be used for the enhancement and conservation of terrestrial wildlife habitat and the protection of stream quality, fish, and waterfowl;

5. identification of areas that should be closed to certain types of recreational activity, or ways to regulate access in such areas, or alternative recreation areas;

6. development and dissemination of information about wildlife concerns in the region; and

7. development of an outreach program or liaison to keep new officials informed about wildlife concerns in the area and sources of expert assistance.

REDUCING OR AVOIDING ADVERSE IMPACTS OF HUMAN ACTIVITIES

This section discusses measures to mitigate adverse human demographic impacts by controlling or minimizing poaching, hunting and fishing pressure, harassment and predation by dogs, road kills, barriers to animal movement, snowmobile and ORV use, and nonconsumptive recreation demand.

Controlling Poaching

Significant increases in human population may result in increased poaching. Mitigation of the adverse impacts of poaching can include:

1. more effectively enforcing local and State laws regarding illegal hunting and fishing; e.g., increasing the number of game wardens assigned to an impact area;

2. banning firearms in problem areas (e.g., areas with seriously declining raptor populations);

3. encouraging citizens to participate in violation reporting programs;

4. requesting industries to provide funding to agencies so that they can hire more enforcement personnel;

5. providing voluntary or, in severe problem areas, mandatory bussing of mine employees from communities to work;

6. staggering mine employee work shifts to avoid big game feeding periods;

144

7.   promoting education programs for in-migrants through their employers on the value of fish and wildlife, State and Federal game laws, and hunting ethics;

8.   requesting industries to institute industry fines for wildlife violators who are industry employees; and

9.   fencing access to lakes and ponds where illegal fishing is occurring.

Controlling Increased Hunting Pressure

Measures that will help control increased hunting pressure include:

1.   encouraging industry to open new lands (owned or leased) to hunting to relieve pressure on currently available lands;

2.   recommending additional public use area development based on surveys of future public recreation needs;

3.   closing critical habitat areas for species that are especially sensitive to human disturbance;

4.   restricting hunting as necessary through standard game management practices, such as permitting, length and time of season, and bag limits; and

5.   potential use of trespass fees to allow increased use of private lands by hunters.

Controlling Increased Fishing Pressure

Where increased fishing pressure is likely to result in adverse impacts on aquatic systems, possible mitigation techniques include:

1.   imposing size and bag limits, shortening the season, and permitting;

2.   changing fishing methods (e.g., flies and lures instead of live bait and catch and release instead of catch and keep fishing);

3.   imposing a user fee;

4.   controlling access, especially vehicle access; and

5.   increasing stocking levels in existing or newly accessible fishing areas.

Controlling Harassment and Predation by Uncontrolled Dogs

Impacts to wildlife from uncontrolled pets have increased markedly in recent years and are likely to continue to increase. Mitigation measures include:

1. providing public education about the problem in order to gain pub-
lic support for controlling pets;

2. passing legislation that gives law enforcement personnel legal
authority to destroy domestic pets that are harassing wildlife;

3. passing legislation that makes the owner liable for damage to wild-
life done by his or her pets;

4. developing and enforcing regulations requiring that dogs be leashed
or otherwise controlled in designated problem areas;

5. destroying uncontrolled dogs running in packs in known problem
areas; and

6. prohibiting dogs in subdivisions that are near important big game
habitat or requiring that dogs be confined with fences in these subdivisions.

The Colorado Division of Wildlife initiated legislation, subsequently
adopted, that gave wildlife conservation officers the authority to dispose
of dogs caught in the act of harassing wildlife. Provisions were also in-
cluded that made pet owners liable for damage done by their pets (Pre et al.
1978). However, in Routt County, Colorado, recommendations by the Division
of Wildlife that subdivisions near important big game habitat either prohibit
dogs or confine them with fences have met with severe opposition.

Minimizing Road Kills

High speed and high volume road traffic, particularly in big game con-
centration areas, creates hazards to both wildlife and motorists. The prob-
lem is greatest where roads cross game migration routes. This problem can
be reduced by:

1. fencing used in combination with overpasses or underpasses for
    game;

2. timing work schedules and using mass transit or car pools to reduce
    the amount of traffic;

3. reducing speed limits at heavily used game crossings;

4. using highway lighting at problem areas; and

5. minimizing the number and degree of curves and hills on new roads
    built in problem areas.

A recent paper (Reed, Beck and Woodard 1982) described the cost effi-
ciency of 2.6-yd fencing and associated structures designed to reduce deer-
vehicle accidents, and provided benefit-cost analysis procedures for use in
planning impact mitigation. Prefence mortality levels between 6 and 30 deer/
mi of highway/yr were considered, and benefit-cost ratios for fencing on one
side, both sides, and fencing on both sides with an underpass were included.

146

Table 10. Relationships of prefence dead deer/1.6 km/yr values to benefit:cost (B:C) ratios (Reed et al. 1982)

Number of dead deer/1.6 km/yr[a]	B:C ratio		
	Fencing on one side	Fencing on both sides	Fencing on both sides with underpass
6	1.02:1	0.51:1	0.34:1
7	1.19:1	0.60:1	0.40:1
8	1.36:1	0.68:1	0.45:1
9	1.53:1	0.77:1	0.51:1
10	1.70:1	0.85:1	0.57:1
11	1.87:1	0.94:1	0.62:1
12	2.04:1	1.02:1	0.68:1
13	2.21:1	1.11:1	0.74:1
14	2.38:1	1.19:1	0.79:1
15	2.55:1	1.28:1	0.85:1
16	2.72:1	1.36:1	0.91:1
17	2.90:1	1.45:1	0.97:1
18	3.07:1	1.53:1	1.02:1
19	3.24:1	1.62:1	1.08:1
20	3.41:1	1.70:1	1.14:1
21	3.58:1	1.79:1	1.19:1
22	3.75:1	1.87:1	1.25:1
23	3.92:1	1.96:1	1.31:1
24	4.09:1	2.04:1	1.36:1
25	4.26:1	2.13:1	1.42:1
26	4.43:1	2.21:1	1.48:1
27	4.60:1	2.30:1	1.53:1
28	4.77:1	2.38:1	1.59:1
29	4.94:1	2.47:1	1.65:1
30	5.11.1	2.55:1	1.70:1

[a]1.6 km = 0.99 mi

The model assumed a fence about 2 mi long, vehicle repair cost of $500/collision with a deer, individual deer value of $350, fence effectiveness of 75 percent, fence life of 20 yr, discount rate of 6.0 percent, fence cost of $85,000, and annual fence maintenance cost of 1.0 percent of initial fence cost. The benefit-cost ratios are shown in Table 10. Assuming a threshold benefit-cost ratio of 1.02:1, then 6, 12, and 18 dead deer/mi/yr are the minimum preference mortalities for cost effective use of 2.6-yd fencing on one side, both sides, or both sides with an underpass, respectively. The authors recommend a more conservative minimum benefit-cost ratio of 1.36:1, with 8, 16, and 24 dead deer/mi/yr for the three mitigation alternatives.

There is some question as to the effectiveness of animated neon deer crossing signs (Colorado Division of Wildlife 1980) and highway reflectors (Reed and Woodard 1981). Experimentation with reflectors is continuing in northwestern Colorado.

Fences along the highway can be used to channel animals toward a pass. On Colorado's Interstate 70, deer regularly use overpasses and large bridge-type underpasses, but many are reluctant to use small concrete box culvert-type underpasses (Reed et al. 1975).

Minimizing Barriers to Animal Movements

Fences are the most frequent obstruction to migration and local wild-life movements. During winter, fences may prevent animals from moving to winter range. Big game animals can become injured or die when they become entangled in fence wires. Barriers to big game movement also include over-land conveyor systems, railroads, highways, powerlines in the flight path of waterfowl, and openings cut into riparian corridors. A significant number of birds are killed annually by collisions with objects that are poorly visible to them, such as wires strung across their flight path, reflective objects (e.g., windows), or structures with point sources of illumination that attract, disorient, or confuse birds on overcast nights.

Potential mitigation measures for these types of barriers include:

1. Highway underpasses can be built and fences used to channel wild-life towards underpasses where roads cross big game routes. Pronghorn, how-ever, will not use underpasses (Ward, pers. comm.). When planning big game passage structures, an important consideration is to locate the structures in areas of suitable cover and topography, where natural animal movement occurs.

2. Fences can be built that allow deer passage over the fence and pronghorn passage under the fence (U.S. Bureau of Land Management 1975; Yoakum et al. 1980). Most States have design specifications for fences that have proven successful, although this technique is sometimes con-founded in deep snow conditions.

3. Fences can be built with adjustable wires that can be seasonally raised or lowered to allow free movement of deer and pronghorn in areas when livestock are not present (Anderson and Denton 1980). This is an effective approach, although it requires considerable labor to adjust the fence heights.

4. Conveyor systems, railroads, and highways can be planned to avoid or allow for big game migration corridors.

5. Pronghorn passes (modified cattle guards) can be built into fence systems on migration routes and important pathways (Mapston and ZoBell 1972). However, in Wyoming, passes have been much less effective than using less restrictive fences and drop panels. Drop panels work only when they are well maintained, however.

6. Wires can be carefully sited to avoid flight patterns, decreasing the reflectivity of surfaces, substituting ultraviolet or infrared light in airport ceilometers, and using on-off lighting cycles for warning lights and ceilometers on overcast nights during bird migration (Jaroslow 1979).

Controlling Snowmobile and ORV Use

Potential mitigation measures for snowmobile and ORV use include:

1.   Snowmobile users can be taught not to stop or leave their vehicles when passing through big game areas, to avoid open treeless areas on winter range, and to stay in the deeper snow at high elevations. Other snowmobile operators and club members can be effective in promoting a code of ethics that discourages animal harassment.

2.   Trails can be closed when snow is insufficient to prevent damage to vegetation. Snowmobiles should be prohibited in areas of fragile vegetation, areas important for nesting birds, or other important wildlife habitat.

3.   Hunting from snowmobiles can be prohibited or their use restricted during hunting season.

Controlling Increased Nonconsumptive Recreation Demand

When public areas potentially will be overused due to increased nonconsumptive recreation demand, placing more emphasis on developing nonconsumptive use opportunities on private lands is one alternative. Conservation organizations or local recreation departments could be used to bring landowners together to discuss this alternative. A user fee for wildlife observation by groups or club members could be tested, with administration the responsibility of the group or club.

Summary: Wildlife Mitigation

Table 11 presents mitigation alternatives for each main category of human demographic impact on wildlife from population growth associated with energy development. Mitigation is most effectively the responsibility of an areawide task force, with representatives from Federal and State agencies, local governments, planners, developers, the construction trade, mining industries, and environmental organizations.

149

Table 11. Mitigation measures to reduce adverse human demographic impacts on fish and wildlife resulting from energy developments

Adverse impact to be mitigated[a]						Mitigation actions
Hab.	B.A.	Har.	R.K.	Poach.	Dogs	
X						Develop an areawide map for local officials and planners that identifies key habitat for target species
X						Map critical movement corridors for big game; evaluate the feasibility of conservation easements to protect corridors from development
X						Develop an areawide habitat enhancement plan for target species (consider both game and nongame species). Enhancement may include:
X	X					. Fertilize key winter range annually . Work with landowners to ensure minimal disturbance of brush cover in big game parturition areas and summer range
X						. Work with landowners to ensure minimal disturbance of riparian cover within 100 ft to 0.25 mi of all drainage courses (depending on stream size)
X						. Revegetate cleared or disturbed areas after development (e.g., linear facilities) using species compatible with the vegetation type disturbed
X						. Selectively develop additional surface water storage areas along existing drainages (e.g., low head dams, springs, and water holes) where these areas would enhance habitat of any target species
X						. Consider purchase of water rights to maintain adequate distribution and levels of surface water where water is a limiting factor for target species during summer months
X						Enforce laws protecting raptors and increase public education efforts concerning raptors

150

Table 11 (Continued).

Adverse impact to be mitigated						Mitigation actions
Hab.	B.A.	Har.	R.K.	Poach.	Dogs	
X						Design a developer awareness program to encourage preservation of vegetation islands, patches, and irregular areas of natural habitat around dispersed rural facilities
X						Initiate a short course for employees in construction trades on reasons for and techniques used to minimize wildlife habitat disturbances. Utilize a professional consultant, educator, or resource professional to conduct the course. Encourage developers and/or construction companies to attend short courses
X						Design trails and clearings to ensure natural connecting lanes of vegetation in major recreation areas
X		X				Initiate a public awareness program to help increase sensitivity to wildlife needs during critical periods
	X	X				Limit access and human activities in designated big game parturition areas during May and June--time will vary by species and location
	X	X				Where community growth is near key habitat areas, restrict human activity to designated areas only (e.g., established recreation lands, public roads, and residential areas)
X	X	X				Where key habitats (e.g., bald eagle roosting sites) occur on private lands, strive for landowner cooperation to minimize site disturbance

151

Table 11 (Continued).

Hab.	B.A.	Har.	R.K.	Poach.	Dogs	Mitigation actions
X	X	X				Exclude livestock and humans from designated big game parturition areas and key summer range from May through November
	X	X				Reduce or eliminate extraneous disturbances (e.g., blasting and heavy equipment operation) within 0.5 mi of movement corridors of big game and from key habitat of other target species
X	X	X	X	X	X	Use public education programs to sensitize mining industry employees to the need for minimizing disturbances to wildlife during and after development
X	X	X			X	Create public awareness of the need for not disturbing big game on winter range
	X	X				Encourage people not to stop their vehicles when big game are sighted off roads unless necessary for regular job duties or emergencies
			X			Close roads from 1600 hours to 1800 hours during big game migration periods (May to June and October to November) where road kills are a problem
			X			Reduce vehicle speeds to 25 mph during migration periods where problem roads cannot be closed
			X			Install roadside reflecting devices on problem roads or, where necessary, build overpasses for big game movement
				X		Prohibit firearms and hunting in big game birthing areas and movement corridors during critical periods
X	X	X		X		Prohibit off-road vehicles in summer range, birthing areas, and movement corridors from May to November and on winter range from October to May

152

Table 11 (Concluded).

Adverse impact to be mitigated						Mitigation actions
Hab.	B.A.	Har.	R.K.	Poach.	Dogs	
				X		Increase patrols on access roads from October to May where poaching is a problem
				X		Establish employee penalties for wildlife law violations
					X	Prohibit uncontrolled dogs in designated winter range, including shooting of offenders
X	X					Place salt stations that will attract big game away from areas of development and human activity

Source: Thorne Ecological Institute and Midwest Research Institute.

[a]Hab. = Habitat loss, alteration, or degradation
B.A. = Behavioral avoidance
Har. = Harassment
R.K. = Road kills
Poach = Poaching
Dog = Harassment, predation by dogs

153

SECTION 11

SAMPLE DATA AND WORKSHEETS BASED
ON DUNN COUNTY METHANOL PLANT

DEMOGRAPHIC IMPACT ASSESSMENT

The project selected for demonstration of the impact assessment meth-
odology is a proposed methanol plant located in Dunn County, North Dakota.
The project would utilize 13 to 14 million tons of lignite coal annually
and would employ about 2,100 permanent operations and maintenance personnel.
The construction work force would peak at about 4,100. This facility thus
appears to be a reasonably typical example of the coal-fired synthetic fuel
projects which are being proposed for development in several of the Western
States.

The site is also quite typical of the areas where many new energy proj-
ects are being located. Dunn County had a population of about 4,600 in 1980
while the largest town in the county (Killdeer) had slightly less than 800
residents. Agriculture is the major basic industry in this area, but oil
and gas exploration and extraction have become increasingly important in
recent years.

The study area (impact area) for the analysis includes Dunn County and
two adjacent counties, Mercer and Stark (Figure 11). Mercer County borders
Dunn County on the east and is the site of several large coal conversion
facilities. Two of these facilities are presently under construction, and
it appears likely that many construction workers now living in Mercer
County will commute daily to Dunn County to work at the methanol plant.
Stark County borders Dunn County on the south, and its major city (Dickinson,
with a population of about 16,000) is the regional trade and service center
for the Dunn County area. It appears likely that a substantial fraction of
the in-migrating construction workers will live in Dickinson and that much
of the project-related secondary employment will be located there. A summary
of the populations of these counties and towns and their distances from the
proposed project site is presented below:

154
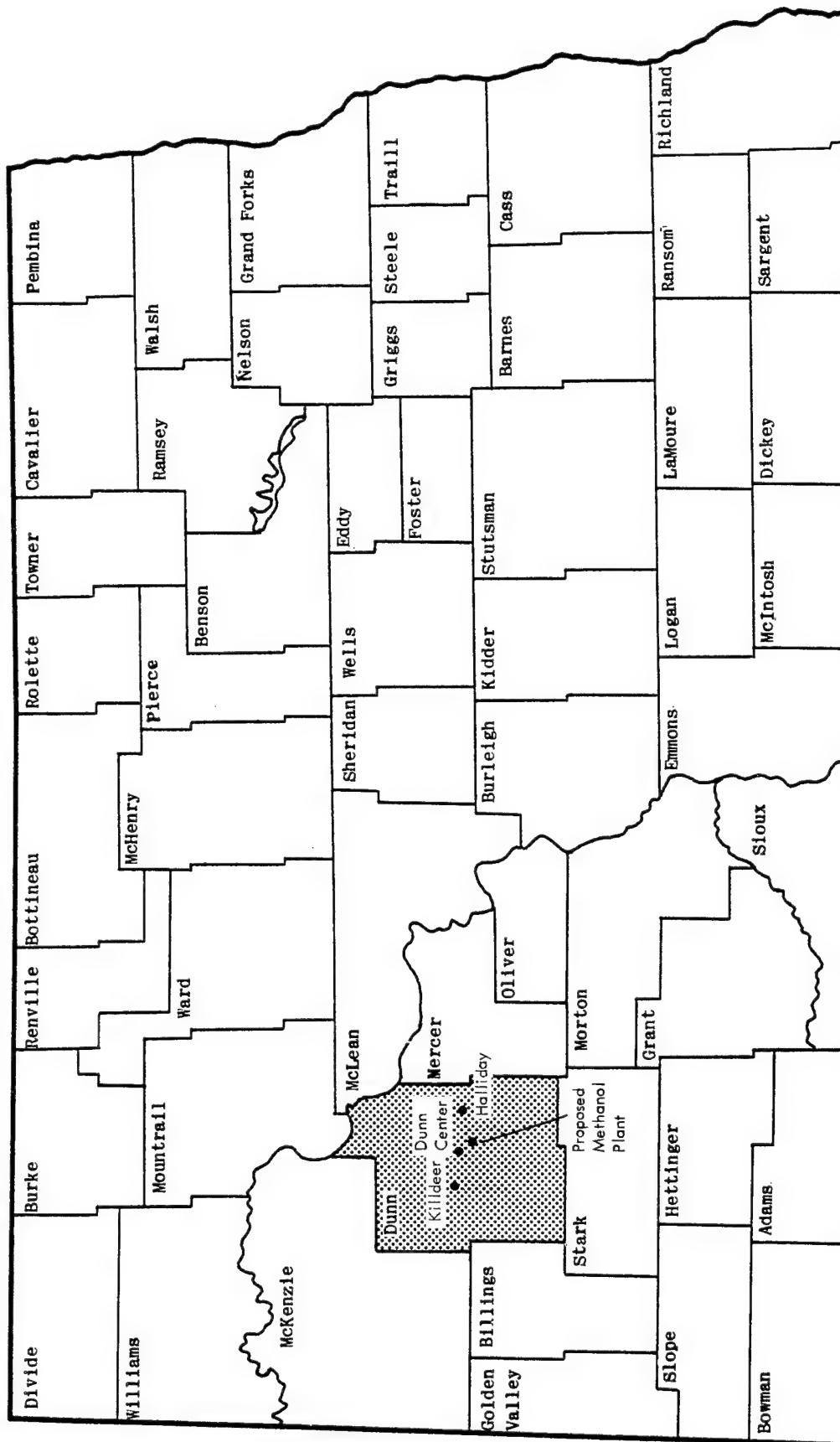
Figure 11. Study area.

County/town	1980 Population	Distance from project site (miles)
Dunn County	4,627	--
Killdeer	791	12
Halliday	355	13
Dunn Center	169	5
Mercer County	9,404	--
Beulah	2,878	41
Hazen	2,376	49
Zap	512	36
Stark County	23,697	--
Dickinson	15,893	45

Examination of the area's transportation network indicates that no other counties are likely to experience significant effects associated with project-related in-migration.

Steps 1 and 2 -

Estimates of direct construction and operations work force requirements were obtained from the developer (Nokota Company, Bismarck, ND). These estimates were compared with the values shown for similar facilities in Appendix B (Table B-2) and appeared reasonable. The direct work force requirements were then entered into the worksheet (Step 1).

Estimating the secondary employment effects of the project required choosing multiplier values appropriate to the characteristics of the project and site area. For the construction multiplier, a value of 0.5 was selected. This value lies at the midrange of the suggested values for sparsely populated areas (see worksheet instructions). For the operations multiplier, a value of 1.1 was selected. This value lies near the upper end of the range of suggested values for sparsely populated areas, but several factors suggest the use of a higher than average value:

1.   Nokota Company officials indicated a policy of buying supplies and materials within the study area whenever practical.

2.   Past coal and petroleum activity in the area has resulted in development of a substantial pool of workers with skills appropriate for work in the methanol facility and also has led to creation of a number of specialized service firms capable of supplying the methanol facility.

3.   The relative isolation of the study area from larger trade and service centers suggests that most of the secondary effects will be contained within the three-county area.

156

When secondary employment is computed in the worksheet, the "ceiling to nonbasic employment growth" constraint does not take effect. Because a substantial operations work force is projected to be at the site during the latter part of the construction period, however, the total secondary employment associated with the facility rises to a peak of 3,541 in year 5 before stabilizing at a level of 2,328 during the operations phase (year 8 and thereafter). This estimate appears reasonable because considerable infrastructure construction (e.g., housing, schools) is likely to occur during the project construction period.

Because the construction period for this project is relatively lengthy (7 years), the worksheet (Steps 1 and 2) is extended to provide direct and secondary employment projections for 10 years. Subsequent worksheet steps are completed for years 3 and 10 (1987 and 1994). Year 3 is the year of maximum direct construction employment, while year 10 is the third year of full project operation. These two years thus provide a view of the effects of both project stages.

Step 3

In Step 3 of the worksheet, estimates of a number of key parameters are required. The local hire rate for construction workers is estimated to be 40 percent. This value is at the midrange of suggested values and appears typical for western coal projects. While the project's labor requirements are large in relation to the area's labor pool, the area also has an unusually high percentage of skilled construction craftsmen because of a legacy of coal development projects.

The percentage of construction workers who will be single or who will commute to the area on a weekly basis is estimated to be 30 percent. This value is the midrange of suggested values and is typical for western energy projects.

The local hire rate for operations workers is estimated to be 60 percent. This value is consistent with the past experience of energy projects in western North Dakota.

Because little empirical evidence is available concerning local hire rates for secondary workers or the percentage of direct workers' spouses who would take secondary jobs, these parameters are set at the midrange of the standard values. The same rationale was used in establishing the percentage of locally hired direct workers that would represent jobs to be filled by in-migrating workers.

Steps 4 and 5

In Step 4, standard values were utilized throughout as these values were derived from surveys of coal projects located in areas similar to the Dunn County site.

In Step 5, residential allocation shares were computed for Dunn and Mercer Counties and for Killdeer, Halliday, Dunn Center, and rural Dunn County. These estimates were based on consideration of community infrastructure, distances and road conditions, the developer's plans for provision of single status housing for the construction workers, and the developer's executed policy with respect to residential location of operations workers.

Estimation of residential allocation shares was accomplished through a two-step procedure. First, the gravity model was utilized to estimate residential patterns for construction and operations personnel. The gravity equations (see Appendix B) were applied to the communities of Killdeer, Halliday, and Dunn Center in Dunn County; Beulah, Hazen, and Zap in Mercer County; and Dickinson in Stark County. The resulting estimates of residential shares were as follows:

County/Community	Construction workers	Operations workers
Dunn County	30.3	42.1
Killdeer	13.5	16.7
Halliday	7.9	10.8
Dunn Center	8.9	14.6
Mercer County	31.0	30.8
Beulah	14.2	13.3
Hazen	11.4	10.8
Zap	5.4	6.7
Stark County	38.5	27.1
Dickinson	38.5	27.1

These estimates were then reviewed in light of the developer's plans and policies and knowledge of study area conditions. Because the developer expressed an intention to provide single status housing in Dunn County for a portion of the construction work force, the percentage of the construction workers expected to reside in Dunn County was revised upward. The proportion of operation workers expected to reside in Dunn County communities was revised upward sharply (from 42 to 80 percent) because of the developer's policy of requiring most employees to live near the plant site. Within Dunn County, the allocation factors among communities were adjusted to allocate a higher percentage of all worker types to Killdeer. This was done because of Killdeer's stronger retail trade and service base and more extensive public service infrastructure. In addition, area housing developers have expressed a strong preference for Killdeer as the site within Dunn County to develop new housing units. The revised residential allocation estimates were thus:

DEMOGRAPHIC IMPACT ASSESSMENT

Step 1 - Projecting Direct Employment

Year	1 1985	2 1986	3 1987	4 1988	5 1989	6 1990	7 1991	8 1992	9 1993	10 1994
1. Operations (permanent) employment	0	120	650	1,435	1,537	1,810	2,116	2,116	2,116	2,116
2. Construction (temporary) employment	583	3,219	4,118	2,718	3,699	2,686	142	0	0	0

Step 2 - Estimating Secondary Employment

Year	1	2	3	4	5	6.	7	8	9	10
1. Operations-related secondary employment (operations work force x 1.1)	0	132	715	1,579	1,691	1,991	2,327	2,328	2,328	2,328
2. Construction-related secondary employment[a] (construction work force x 0.5)	292	1,610	2,059	1,359	1,850	1,343	71	0	0	0
3. Total secondary employment (sum of lines 1 and 2)	292	1,742	2,774	2,938	3,541	3,334	2,398	2,328	2,328	2,328

[a] May not exceed operations-related secondary employment (average for first 2 years after construction ends).

159

Community/county	Construction workers	Operation workers	Secondary workers
Killdeer	25	45	30
Halliday	8	15	6
Dunn Center	5	12	3
Rural Dunn County (including Werner)	2	8	1
Dunn County	40	80	40
Mercer County	30	10	20
Stark County	30	10	40

In summary, the gravity model is a useful technique for developing initial estimates of residential patterns for project-related workers. These initial results should always be evaluated, however, in light of local conditions.

Baseline population projections for Dunn County and the communities selected were based on an assumption of a 1 percent annual growth rate. This growth rate is consistent with recent projections for this area.

	Year 1987	Year 1994

<u>Step 3</u> - Estimating In-Migrating Fraction of Workers

<u>Construction Workers and Dependents</u>

1. Total construction workers = _____
    (from Step 1, Line 2)   4,118   0

2. Local workers = (0.3-0.5) [range] __0.4__ [value] x Line 1
    = _____ workers   1,647   0

3. Single workers and
    weekly commuters   = (0.2-0.4) [range] __0.3__ [value]
    x Line 1 = _____ workers   1,235   0

4. In-migrating workers
    with families   = (Line 1 minus sum of
                        Lines 2 & 3) = _____ workers   1,236   0

5. Total in-migrating construction workers (Line 3 +
    Line 4) = _____ workers (to Step 4)   2,471   0

6. In-migrating spouses (Line 4 x 1.0) =
    _____ spouses (to Step 4)   1,236   0

7. In-migrating children (Line 4 x 1.4)
    = _____ children (to Step 4)   1,730   0

<u>Operation Workers and Dependents</u>

8. Total operations workers = _____
    (from Step 1, Line 1)   650   2,116

9. Local workers = (0.4-0.7) [range] __0.6__ [value] x Line 8
    = _____ workers   390   1,270

10. Total in-migrating operation workers = (Line 8
    minus Line 9) = _____ workers (to Step 4)   260   846

11. In-migrating spouses = (0.7-0.8) [range] __0.8__ [value]
    x Line 10 = _____ workers (to Step 4)   208   677

12. In-migrating children (Line 11 x   1.4)
    = _____ children (to Step 4)   291   948

161

	Year 1987	Year 1994

<u>Secondary and Replacement Workers and Dependents</u>

13. Total secondary employment
    (from Step 2, Line 3) = _____   2,774   2,328

14. Local workers = $\overline{(0.5-0.7)}^{\text{range}}$ $\overline{0.6}^{\text{value}}$ x Line 13
    = _____ workers   1,664   1,397

15. Construction and operation workers' $\overline{(0.2-0.4)}^{\text{range}}$ $\overline{0.3}^{\text{value}}$
    spouses available for employment =
    x sum of Lines 6+11) = _____ workers   433   203

16. In-migrating secondary workers = Line 13 -(sum of
    Lines 14+15) = _____ workers   677   728

17. Replacement workers = $\overline{(0.3-0.5)}^{\text{range}}$ $\overline{0.4}^{\text{value}}$ x (sum of
    Lines 2+9) = _____ workers   815   508

18. Total in-migrating secondary and
    replacement workers = (sum of Lines 16+17)
    = _____ workers   1,492   1,236

19. In-migrating single workers = $\overline{(0.2-0.3)}^{\text{range}}$ $\overline{0.2}^{\text{value}}$
    x Line 18 = _____ workers   298   247

20. In-migrating families = (Line 18 minus Line 19)
    ÷ 1.4 (or your value) = _____   853   706

21. In-migrating worker households = (sum of Lines 19+20)
    = _____ workers (to Step 4)   1,151   953

22. In-migrating spouses = (Line 20 x 1.0)
    = _____ spouses (to Step 4)   853   706

23. In-migrating children = (Line 20 x 1.4)
    = _____ children (to Step 4)   1,194   988

Step 4 - Constructing a Population Profile of In-Migrants

Construction Population

							Year 1987	Year 1994
1.	Male workers = (value from Step 3, Line 5)			= _____			2,471	0

	Age category	Standard value	Your value	x Line 1				
1.a.	20-24	(0.240)	____	____	=	____	593	
1.b.	25-34	(0.406)	____	____	=	____	1,003	
1.c.	35-44	(0.159)	____	____	=	____	393	
1.d.	45-64	(0.195)	____	____	=	____	482	

							Year 1987	Year 1994
2.	Female spouses = (value from Step 3, Line 6)			= ____			1,236	0

	Age category	Standard value	Your value	x Line 2				
2.a.	20-24	(0.240)	____	____	=	____	297	
2.b.	25-34	(0.406)	____	____	=	____	502	
2.c.	35-44	(0.159)	____	____	=	____	196	
2.d.	45-64	(0.195)	____	____	=	____	241	

						Year 1987	Year 1994
3.	Children = (value from Step 3, Line 7) = _____					1,730	0
4.	Male children = Line 3 x 0.5 = _____ = Female children					865	0

	Age category	Standard value	Your value	x Line 4	Males and Females		Year 1987	Year 1994
4.a.	< 5	(0.354)	____	____	=	____	306	
4.b.	5-11	(0.361)	____	____	=	____	312	
4.c.	12-14	(0.114)	____	____	=	____	99	
4.d.	15-17	(0.108)	____	____	=	____	93	
4.e.	18-19	(0.038)	____	____	=	____	33	
4.f.	20-24	(0.025)	____	____	=	____	22	0

Operation Population

		Year 1987	Year 1994
5.	Operation Workers = (value from Step 3, Line 10) = _____	260	846

		Standard value	Your value		1987	1994
5.a.	Male workers = (Line 5 x	0.9 or	_____) = _____		234	761
5.b.	Female workers = (Line 5 minus line 5.a.) = _____				26	85

Year 1987

	Age category	Standard value	Your value	x Line 5a = Males		x Line 5b = Females
5.c.	20-24	(0.196)	_____	x 234 = 46	x	26 = 5
5.d.	25-34	(0.526)	_____	x 234 = 123	x	26 = 14
5.e.	35-44	(0.167)	_____	x 234 = 39	x	26 = 4
5.f.	45-64	(0.111)	_____	x 234 = 26	x	26 = 3

Year 1994

	Age category	Standard value	Your value	x Line 5a = Males		x Line 5b = Females
5.c.	20-24	(0.196)	_____	x 761 = 149	x	85 = 17
5.d.	25-34	(0.526)	_____	x 761 = 400	x	85 = 45
5.e.	35-44	(0.167)	_____	x 761 = 127	x	85 = 14
5.f.	45-64	(0.111)	_____	x 761 = 84	x	85 = 9

		1987	1994
6.	Operation Spouses = (value from Step 3, Line 11) = _____	208	677

		Standard value	Your value		1987	1994
6.a.	Male spouses = (Line 6 x	0.1 or	_____) = _____		21	68
6.b.	Female spouses = (Line 6 minus Line 6.a.) = _____				187	609

Year 1987

	Age category	Standard value	Your value	x Line 6a = Males		x Line 6b = Females
6.c.	20-24	(0.196)	_____	x 21 = 4	x	187 = 37
6.d.	25-34	(0.526)	_____	x 21 = 11	x	187 = 98
6.e.	35-44	(0.167)	_____	x 21 = 4	x	187 = 31
6.f.	45-64	(0.111)	_____	x 21 = 2	x	187 = 21

Year 1994

	Age category	Standard value	Your value	x Line 6a = Males		x Line 6b = Females
6.c.	20-24	(0.196)	_____	x 68 = 13	x	609 = 119
6.d.	25-34	(0.526)	_____	x 68 = 36	x	609 = 320
6.e.	35-44	(0.167)	_____	x 68 = 11	x	609 = 102
6.f.	45-64	(0.111)	_____	x 68 = 8	x	609 = 68

164

<u>Step 4</u> - Construction Population Profile of In-Migrants (Cont'd)

7. Male children = (Step 3, Line 12 x 0.5) = _____ = Female children   146   474

Year <u>1987</u>

	Age category	Standard value	Your value	x Line 7			
7.a.	< 5	(0.392)	___	146	=	57	Males and Females
7.b.	5-11	(0.348)	___	146	=	51	
7.c.	12-14	(0.133)	___	146	=	19	
7.d.	15-17	(0.095)	___	146	=	14	
7.e.	18-19	(0.025)	___	146	=	4	
7.f.	20-24	(0.007)	___	146	=	1	

Year <u>1994</u>

	Age category	Standard value	Your value	x Line 7			
7.a.	< 5	(0.392)	___	474	=	186	Males and Females
7.b.	5-11	(0.348)	___	474	=	165	
7.c.	12-14	(0.133)	___	474	=	63	
7.d.	15-17	(0.095)	___	474	=	45	
7.e.	18-19	(0.025)	___	474	=	12	
7.f.	20-24	(0.007)	___	474	=	3	

8. Secondary worker households = (value from Step 3, Line 21)

= _____   1,151   953

		Standard value	Your value				
8.a.	Male workers = (Line 8 x	0.6 or	___	) =	___	691	572
8.b.	Female workers = (Line 8 minus Line 8.a.) =		___			460	381

Year <u>1987</u>

	Age category	Standard value	Your value	x Line 8a	= Males	x	Line 8b	= Females
8.c.	20-24	(0.196)	___	x 691	= 135	x	460	= 90
8.d.	25-34	(0.526)	___	x 691	= 363	x	460	= 242
8.e.	35-44	(0.167)	___	x 691	= 115	x	460	= 77
8.f.	45-64	(0.111)	___	x 691	= 77	x	460	= 51

Year <u>1994</u>

	Age category	Standard value	Your value	x line 8a	= Males	x	line 8b	= Females
8.c.	20-24	(0.196)	___	x 572	= 112	x	381	= 75
8.d.	25-34	(0.526)	___	x 572	= 301	x	381	= 200
8.e.	35-44	(0.167)	___	x 572	= 96	x	381	= 64
8.f.	45-64	(0.111)	___	x 572	= 63	x	381	= 42

<u>Step 4</u> - Construction Population Profile of In-Migrants (concluded)   <u>1987</u>   <u>1994</u>

9.   Secondary spouses = (value from Step 3, Line 22) = _____   853   706

<table>
<tr><td></td><td></td><td colspan="2">Standard   Your
value   value</td><td></td><td></td><td></td></tr>
<tr><td>9.a.</td><td>Male spouses = (Line 9 x   0.4 or</td><td>_____</td><td>) = _____</td><td></td><td>341</td><td>282</td></tr>
<tr><td>9.b.</td><td colspan="3">Female spouses = (Line 9 minus Line 9.a.) = _____</td><td></td><td>512</td><td>424</td></tr>
</table>

Year <u>1987</u>

	Age category	Standard value	Your value	x Line 9a	=	Males	‖	x	Line 9b	=	Females
9.c.	20-24	(0.196)	___	x 341	=	67	‖	x	512	=	100
9.d.	25-34	(0.526)	___	x 341	=	179	‖	x	512	=	269
9.e.	35-44	(0.167)	___	x 341	=	57	‖	x	512	=	86
9.f.	45-64	(0.111)	___	x 341	=	38	‖	x	512	=	57

Year <u>1994</u>

	Age category	Standard value	Your value	x Line 9a	=	Males	‖	x	Line 9b	=	Females
9.c.	20-24	(0.196)	___	x 282	=	55	‖	x	424	=	83
9.d.	25-34	(0.526)	___	x 282	=	148	‖	x	424	=	223
9.e.	35-44	(0.167)	___	x 282	=	47	‖	x	424	=	71
9.f.	45-64	(0.111)	___	x 282	=	31	‖	x	424	=	47

10.   Male children = (Step 3, Line 23 x 0.5) = ___ = Female children   597   494

Year <u>1987</u>

	Age category	Standard value	Your value	x Line 10			
10.a.	< 5	(0.392)	___	597	=	234	Males and Females
10.b.	5-11	(0.348)	___	597	=	208	
10.c.	12-14	(0.133)	___	597	=	79	
10.d.	15-17	(0.095)	___	597	=	57	
10.e.	18-19	(0.025)	___	597	=	15	
10.f.	20-24	(0.007)	___	597	=	4	

Year <u>1994</u>

	Age category	Standard value	Your value	x Line 10			
10.a.	< 5	(0.392)	___	494	=	194	Males and Females
10.b.	5-11	(0.348)	___	494	=	172	
10.c.	12-14	(0.133)	___	494	=	66	
10.d.	15-17	(0.095)	___	494	=	47	
10.e.	18-19	(0.025)	___	494	=	12	
10.f.	20-24	(0.007)	___	494	=	3	

Step 4 – Population Summary

Age group	Construction workers and spouses (from lines 1 and 2)	Construction children (from line 4)	Subtotal in-migrating construction-related population	Operation workers (from line 5)	Operation spouses (from line 6)	Operation children (from line 7)	Subtotal in-migrating operations-related population	Secondary workers (from line 8)	Secondary spouses (from line 9)	Secondary children (from line 10)	Subtotal in-migrating secondary population	Total
Males												
< 5	0	306	306	0	0	57	57	0	0	234	234	597
5-11	0	312	312	0	0	51	51	0	0	208	208	571
12-14	0	99	99	0	0	19	19	0	0	79	79	197
15-17	0	93	93	0	0	14	14	0	0	57	57	164
18-19	0	22	33	0	0	4	4	0	13	15	25	52
20-24	593	0	615	46	4	1	51	135	67	4	206	872
25-34	1003	0	1003	123	11	0	134	363	179	0	542	1679
35-44	393	0	393	39	4	0	43	115	57	0	172	608
45-64	482	0	482	26	2	0	28	77	38	0	115	625
11. Subtotal, males	2471	865	3336	234	21	146	401	691	341	597	1629	5365
Females												
< 5	0	306	306	0	0	57	57	0	0	234	234	597
5-11	0	312	312	0	0	51	51	0	0	208	208	571
12-14	0	99	99	0	0	19	19	0	0	79	79	197
15-17	0	93	93	0	0	14	14	0	0	57	57	164
18-19	0	22	33	0	0	4	4	0	0	15	15	52
20-24	297	0	319	5	37	1	43	90	100	4	194	555
25-34	502	0	502	14	98	0	112	242	269	0	511	1124
35-44	196	0	196	4	31	0	35	77	86	0	163	394
45-64	241	0	241	3	21	0	24	51	57	0	108	375
12. Subtotal, females	1236	865	2101	26	187	146	359	460	512	597	1569	4029
13. Total			5,437				760				3197	9394

Note: Totals will not always add exactly due to rounding.

167

Age group	Construction			Operation				Secondary				Total
	Construction workers and spouses (from lines 1 and 2)	Construction children (from line 4)	Subtotal in-migrating construction-related population	Operation workers (from line 5)	Operation spouses (from line 6)	Operation children (from line 7)	Subtotal in-migrating operations-related population	Secondary workers (from line 8)	Secondary spouses (from line 9)	Secondary children (from line 10)	Subtotal in-migrating secondary population	
Males												
< 5	0	0	0	0	0	186	186	0	0	194	194	380
5-11	0	0	0	0	0	165	165	0	0	172	172	337
12-14	0	0	0	0	0	63	63	0	0	66	66	129
15-17	0	0	0	0	0	45	45	0	0	47	47	92
18-19	0	0	0	0	0	12	12	0	0	12	12	24
20-24	0	0	0	149	13	3	165	112	55	3	170	335
25-34	0	0	0	400	36	0	436	301	148	0	449	885
35-44	0	0	0	127	11	0	138	96	47	0	143	281
45-64	0	0	0	84	8	0	92	63	31	0	94	186
11. Subtotal, males	0	0	0	761	68	474	1302	572	281	494	1347	2649
Females												
< 5	0	0	0	0	0	186	186	0	0	194	194	380
5-11	0	0	0	0	0	165	165	0	0	172	172	337
12-14	0	0	0	0	0	63	63	0	0	66	66	129
15-17	0	0	0	0	0	45	45	0	0	47	47	92
18-19	0	0	0	0	0	12	12	0	0	12	12	24
20-24	0	0	0	17	119	3	139	75	83	3	161	300
25-34	0	0	0	45	320	0	365	200	223	0	423	788
35-44	0	0	0	14	102	0	116	64	71	0	135	251
45-64	0	0	0	9	68	0	77	42	47	0	89	166
12. Subtotal, females	0	0	0	85	609	474	1168	381	424	494	1299	2467
13. Total	0	0	0	846	677	948	2470	953	706	988	2646	5116

168

Step 5 - Projecting the Residential Location of In-Migrants

5a. Calculate residential allocation factors for communities of interest

Community (county or municipality)	Percent share		
	Construction population	Operation population	Secondary population
Dunn County	40%	80%	40%
Mercer County	30%	10%	20%
Killdeer (Dunn County)	25%	45%	30%
Halliday	8%	15%	6%
Dunn Center	5%	12%	3%
Rural Dunn County (inc. Werner)	2%	8%	1%

5b. Compute population allocation for each community

Year 1987

Community (county or municipality)	Population type														Total
	Construction				Operation					Secondary					
	(1)	x	(2)	=	(3)	(1)	x	(2)	=	(3)	(1)	x	(2)	= (3)	
Dunn Co.	5437	x	.40	=	2175	760	x	.80	=	608	3197	x	.40	= 1279	4062
Killdeer	5437	x	.25	=	1359	760	x	.45	=	342	3197	x	.30	= 959	2660
Halliday	5437	x	.08	=	435	760	x	.15	=	114	3197	x	.06	= 192	741
Dunn Ctr	5437	x	.05	=	272	760	x	.12	=	91	3197	x	.03	= 96	459
Rur.Dunn	5437	x	.02	=	109	760	x	.08	=	61	3197	x	.01	= 32	202

(1) = Total population (from Step 4, line 13)
(2) = Percent share (from Step 5, line 1)
(3) = Subtotal

Year 1994

Community (county or municipality)	Population type														Total
	Construction				Operation					Secondary					
	(1)	x	(2)	=	(3)	(1)	x	(2)	=	(3)	(1)	x	(2)	= (3)	
Dunn Co.					0	2470	x	.80	=	1976	2646	x	.40	= 1058	3034
Killdeer					0	2470	x	.45	=	1111	2646	x	.30	= 794	1905
Halliday					0	2470	x	.15	=	371	2646	x	.06	= 159	530
Dunn Center					0	2470	x	.12	=	296	2646	x	.03 =	79	375
Rural Dunn					0	2470	x	.08	=	198	2646	x	.01 =	26	224

(1) = Total population (from Step 4, Line 13)
(2) = Percent share (from Step 5, Line 1)
(3) = Subtotal

5c. Compute worker allocation for each community

Year <u>1987</u>

Community (county or municipality	Construction						Operation						Secondary						Total
	(1)	x	(2)	=	(3)		(4)	x	(2)	=	(3)		(5)	x	(2)	=	(3)		
Killdeer	2471	x	.25	=	618		260	x	.45	=	117		1151	x	.30	=	345		1080
Halliday	2471	x	.08	=	198		260	x	.15	=	39		1151	x	.06	=	69		306
Dunn Ctr.	2471	x	.05	=	124		260	x	.12	=	31		1151	x	.03	=	35		190
Rural Dunn	2471	x	.02	=	49		260	x	.08	=	21		1151	x	.01	=	12		82

(1) = Total construction workers (from Step 3, Line 5)
(2) = Percent share (from Step 5a)
(3) = Subtotal, or community share
(4) = Total operation workers (from Step 3, Line 10)
(5) = Total secondary workers (from Step 3, Line 21)

Year <u>1994</u>

Community (county or municipality	Construction						Operation						Secondary						Total
	(1)	x	(2)	=	(3)		(4)	x	(2)	=	(3)		(5)	x	(2)	=	(3)		
Killdeer	0			=	0		846	x	.45	=	381		953	x	.30	=	286		667
Halliday	0			=	0		846	x	.15	=	127		953	x	.06	=	57		184
Dunn Ctr.	0			=	0		846	x	.12	=	102		953	x	.03	=	29		131
Rural Dunn	0			=	0		846	x	.08	=	68		953	x	.01	=	10		78

(1) = Total construction workers (from Step 3, Line 5)
(2) = Percent share (from Step 5a)
(3) = Subtotal, or community share
(4) = Total operation workers (from Step 3, Line 10)
(5) = Total secondary workers (from Step 3, Line 21)

170

Step 5 - Residential Location (concluded)

5d. Compute community population estimates

Year 1987

Community (county or municipality)	Baseline population[a]	+	Project-related population (Step 5b, total)	=	Total population	Increase attributed to project[b]
Dunn Co.	4961	+	4062	=	9023	82%
Killdeer	848	+	2660	=	3508	314%
Halliday	380	+	741	=	1121	195%
Dunn Center	182	+	459	=	641	252%
Rural Dunn (inc. Werner)	3544	+	202	=	3746	6%

[a] Assumes 1% annual growth rate.
[b] Increase over baseline.

Year 1994

Community (county or municipality)	Baseline population[a]	+	Project-related population (Step 5b, total)	=	Total population	Increase attributed to project[b]
Dunn Co.	5319	+	3034	=	8353	57%
Killdeer	909	+	1905	=	2814	210%
Halliday	407	+	530	=	937	130%
Dunn Center	195	+	375	=	570	192%
Rural Dunn (inc. Werner)	3799	+	224	=	4023	6%

[a] Assumes 1% annual growth rate.
[b] Increase over baseline.

(Notes):   Step 5:   Use of the gravity equation

Community	Pop.	Distance	Const. wt.[a]	%	Oper. wt.[b]	%
Killdeer	791	12	$\frac{59.4}{4.4} = 13.5$	13.5	$\frac{20.4}{5.1} = 4.0$	16.7
Halliday	355	13	$\frac{36.4}{4.6} = 7.9$	7.9	$\frac{14.2}{5.4} = 2.6$	10.8
Dunn Center	169	5	$\frac{23.1}{2.6} = 8.9$	8.9	$\frac{10.2}{2.9} = 3.5$	14.6
Beulah	2878	41	$\frac{130.9}{9.2} = 14.2$	14.2	$\frac{36.6}{11.4} = 3.2$	13.3
Hazen	2376	49	$\frac{116.4}{10.2} = 11.4$	11.4	$\frac{33.6}{12.8} = 2.6$	10.8
Zap	512	36	$\frac{45.5}{8.5} = 5.4$	5.4	$\frac{16.8}{10.5} = 1.6$	6.7
Dickinson	15,893	45	$\frac{372.5}{9.7} = 38.4$	38.5	$\frac{79.2}{12.1} = 6.5$	27.1
			Σ	= 99.7	24	

[a] Const. = $A = \dfrac{p^{0.612}}{D^{0.598}}$

[b] Oper. $A = \dfrac{p^{0.452}}{D^{0.656}}$

Shares	Const.	Oper.
Dunn	30.3	42.1
Mercer	31.0	30.8
Stark	38.5	27.1
Killdeer	13.5	16.7
Halliday	7.9	10.8
Dunn Center	8.9	14.6

Residential Allocations

	Const.	Oper.	Secondary
Dunn County	40%	80%	40%
Killdeer	25%	45%	30%
Halliday	8%	15%	6%
Dunn Center	5%	12%	3%
Rural Dunn County (inc. Werner)	2%	8%	1%

LAND USE IMPACT ASSESSMENT

Step 1

Based on conversations with Federal and State game and fish personnel, game species are of primary interest to most Dunn County residents, with nonconsumptive activities, primarily wildlife observation at Lake Ilo National Wildlife Refuge, receiving considerable interest as well. One wildlife-related land use priority, that of maintaining good landowner-hunter relationships in order that hunting on private lands can continue, was explicitly stated. In terms of potential conflicts with land use conversion, two priorities were identified for Dunn County: (a) minimize loss of habitat value on native prairie, wetland riparian, and woodland, and (b) minimize disturbance to habitat values at Lake Ilo National Wildlife Refuge.

Step 2

A driving survey was used to determine if high value habitat areas were likely to be impacted by urban expansion around Killdeer, Halliday, or Dunn Center. These three communities were projected to have project-induced population expansions of 314, 195, and 252 percent, respectively (Worksheet No. 1, Step 5d). Assisting with the survey were wildlife biologists of the U.S. Fish and Wildlife Service and the North Dakota State Game and Fish Department. The survey suggested that the habitat areas of importance near the towns were: (a) Lake Ilo National Wildlife Refuge, located a few miles southwest of Dunn Center; (b) a prairie dog town located north of ND Highway 200 a few miles east of Dunn Center (potential black-footed ferret habitat); and (c) the Spring Creek corridor, in particular the occasional sections of palustrine emergent vegetation. Spring Creek flows through or near the three impact area communities.

Closer site inspection of the communities revealed that only one of the three communities forecast to receive significant population increase, Dunn Center, had developable land in potential conflict with any of three identified priorities for wildlife management. Spring Creek corridor lands near Killdeer and Halliday were not deemed to have high value as riparian habitat, and the prairie dog town was too far from any town to be considered in

173

the path of urban growth. The important potential conflict was on lands near Lake Ilo National Wildlife Refuge, south and west of Dunn Center. This indicated a need for projecting land use conversions associated with the Dunn Center population increase. Other sources of land use conversions (utility corridors, transportation corridors, etc.) attributable to the population growth were not identified.

Step 3

Land use conversions for Dunn Center were developed (see worksheet example). The standard housing percentages for the construction work force were adjusted because the developer indicated plans to provide a significant amount of single status housing (bachelor quarters) for the construction work force. Thus, the percentage of workers accommodated in "other" housing was increased by 10 percent and the percentages for apartments and mobile homes were decreased by 5 percent each. Standard values were generally used; the value of eight units per acre for mobile homes was used based on Dunn County mobile home park standards (North Dakota State University 1977). In general, the assumption guiding the choice of values was that future development would be at a much higher density than old land use patterns would indicate. The calculation for Dunn Center yielded an estimate of 69 acres required for 459 in-migrants, or about 150 acres/1,000 population. This rule of thumb (150 acres/1,000 population) was checked and found consistent with recent energy-related use changes in Beulah, Mercer County (Rodgers, pers. comm.).

Step 4

a. Baseline map. Figure 12 shows the Dunn Center baseline map (North Dakota State University 1977).

b. "Without project" map. A windshield survey was used to compare current (1982/1983) land use with the baseline map. No significant difference was observed. It was assumed that since Dunn Center had received little impact thus far from the several ongoing energy development projects in adjacent Mercer County, in the absence of the proposed project in Dunn County the community would experience no significant expansion between 1983 and 1987 from other Mercer County energy projects. The baseline map (1983) was taken to represent the "without project" map for one evaluation year (1987).

Step 5

The potential conflict zone was identified as that area south of Dunn Center and south of North Dakota Highway 200, along Central Avenue. It was assumed that one-third of the 69 acres projected to be converted to urban uses by 1987 would be in this area. This estimate reflected the importance of a water line already in place on Central Avenue and running south of the sewage disposal plant, plus the proximity of the city's sewage disposal plant. It was expected that future development in this area would be primarily light industrial, with some commercial and residential.
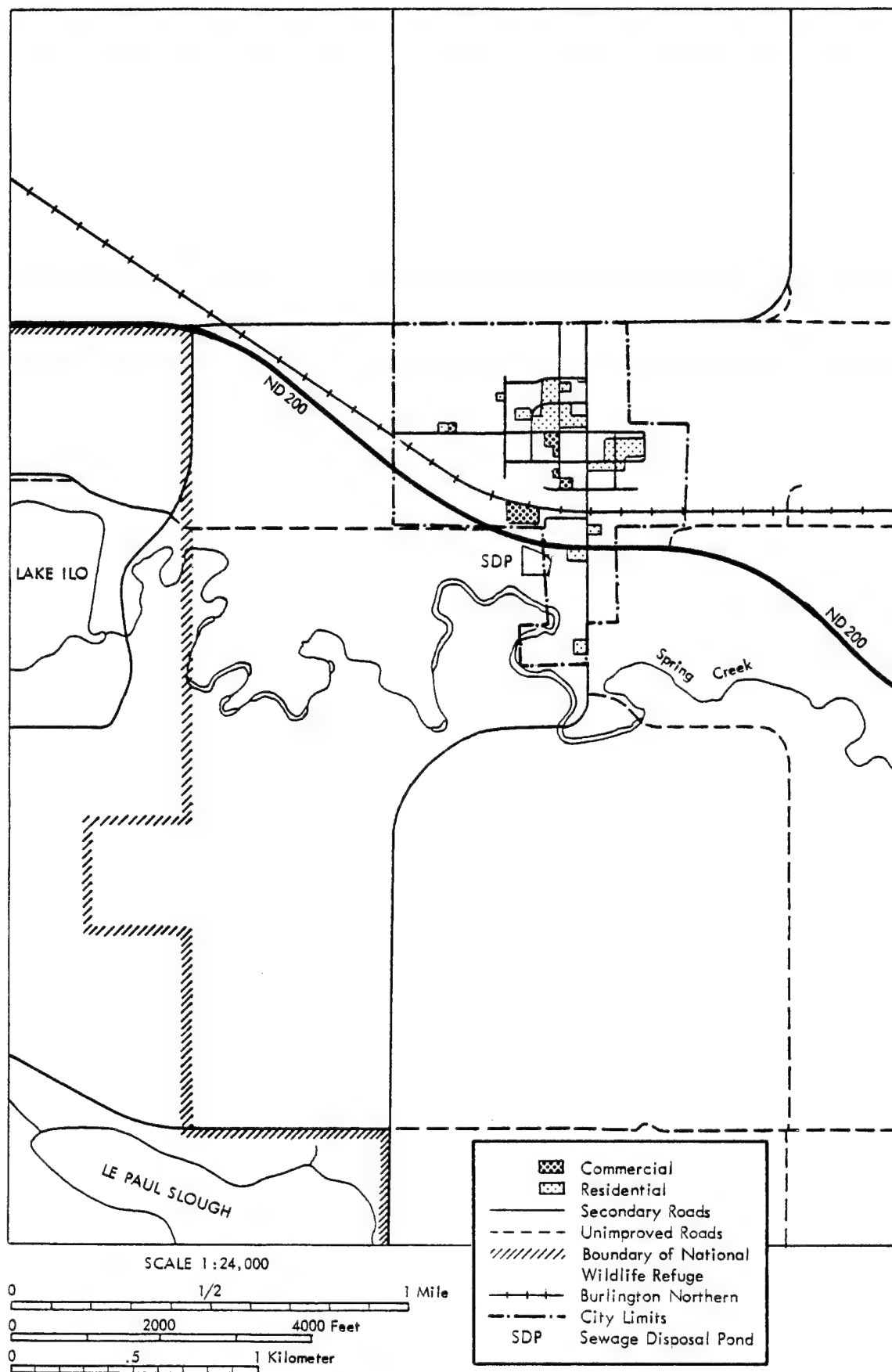
174

Figure 12. Dunn Center, baseline land use map.

175

Figure 13 indicates that while the existing city limits would be adequate to accommodate this development, it is reasonable to expect that due to this development the potential annexation zone could expand significantly toward the wildlife refuge.

Step 6

Land use change projected to occur by 1987 in the potential conflict zone will not require more land than that presently within the city limits. Therefore, the evaluation shifted from potential habitat loss to potential reduced habitat value based on the proximity of urban development to the buffer zone that lies between Dunn Center and Lake Ilo National Wildlife Refuge.

a. Map cover type. Because the direct conversion zone was relatively small in size (approximately 23 acres), the habitat in the potential behavioral avoidance zone was not mapped by cover type. Cover maps were consulted, however, to ascertain the relative quality of habitat currently available and potential evaluation species of interest. Cover maps available from the U.S. Bureau of Land Management were obtained. These maps had been prepared by the U.S. Fish and Wildlife Service, Western Energy and Land Use Team. They followed the surface cover classification system shown in Table E-2 of Appendix E. A radius of 600 yd was selected for the potential behavioral avoidance zone. A radius of 600 yd from the land conversion area south of ND Highway 200 was found to include 339 acres.

b. Select evaluation species. Species observed in the national wildlife refuge nearby include those listed below. For purposes of example, one species--white-tailed deer--was selected as an evaluation species.

Big game
        White-tailed deer

Upland game/small game
        Sharp-tailed grouse
        Ring-necked pheasant
        Mourning Dove
        Squirrel
        Cottontail

Furbearers/predators
        Coyote
        Red fox
        Mink
        Raccoon

Waterfowl
        Duck (mostly mallard)
        Canadian goose

Raptors
        Red-tailed hawk

c. Determine habitat in conflict zone and habitat value loss for each evaluation species. In this example, behavioral avoidance due to the increased proximity of development (industrial, commercial, and some residential) was assumed to be the primary source of reduced habitat value. It was assumed that increased industrial and commercial urban use of land along Central Avenue, the town's main north-south road, would constitute a high level of intrusion into the area. Existing cover quality in the area for white-tailed deer was rated as medium. A zone of approximately 600 yd was designated as the estimated behavioral avoidance zone. This zone is shown in
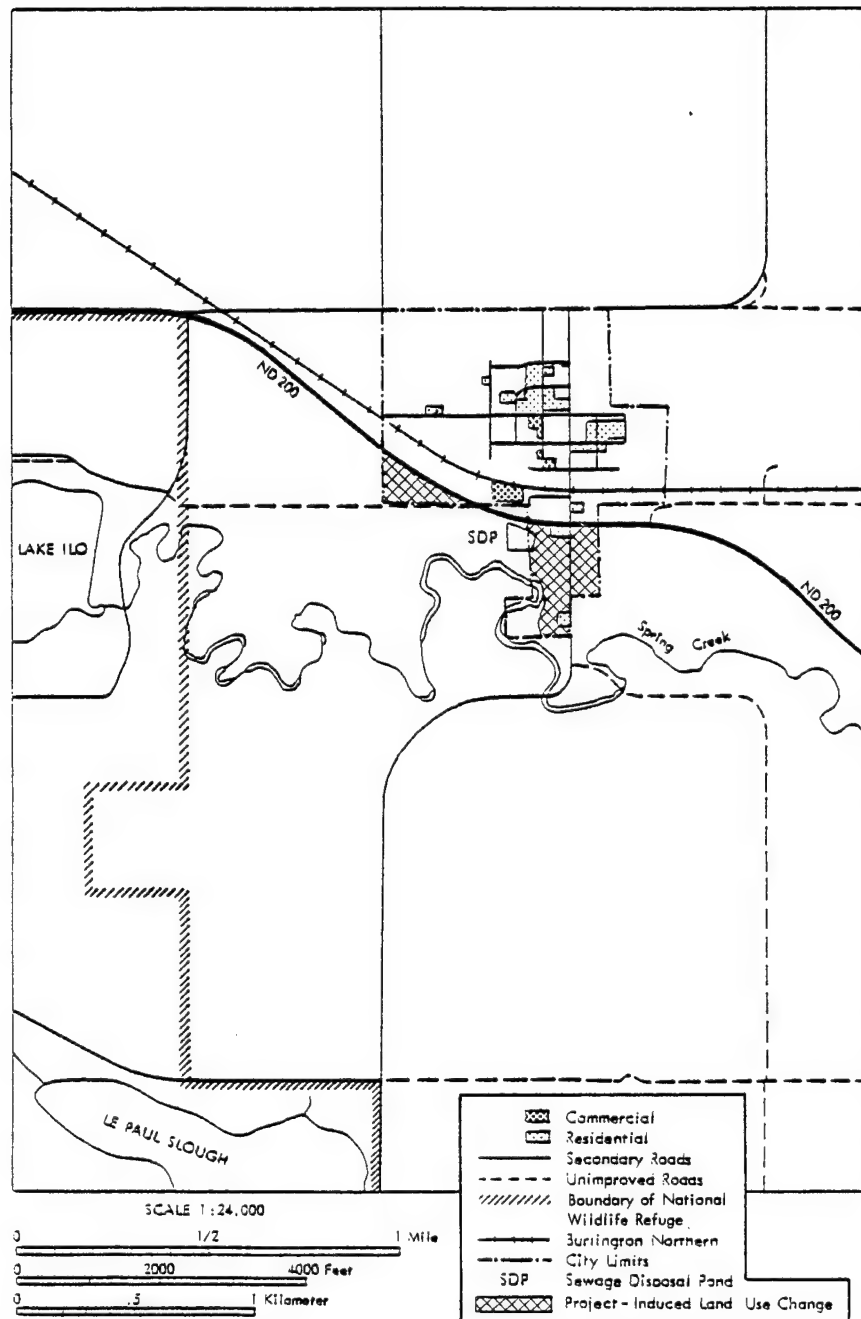
176

Figure 13. Projected Dunn Center land use change, with methanol
plant development.

Figure 14. Habitat value for white-tailed deer in this zone was assumed to be reduced on the average by 50 percent. The 50 percent factor was selected because it was reasoned that the animals would still have escape routes to the west and south. Also, the deer have protected status on the refuge and they may be relatively more trusting of human presence.

Unfortunately, the state of the art of projecting behavioral avoidance by different species under different habitat conditions and from different types of human intrusions is far from the point wherein such designations can be justified as anything but assumptions on the part of local wildlife managers. Still, professional opinion from knowledgeable biologists as to the probable reaction of a given species to nearby urban development is a first step in the direction of quantifying such impacts. In any case, the user should make every attempt to include the rationale for designating a given avoidance zone when summarizing land use impacts from urban development.

d. Determine area by cover type in the conflict zone. Using the map it was estimated that the behavioral avoidance zone for deer equaled about 339 acres. Cover on this area is a mixture of native prairie, wetland, and agriculture-disturbed land. It was decided to assign the area a mean productivity estimate. Variation in value among the three types of cover exists, but locally available density estimates are aggregates of habitat with similar mixes of cover type, so no advantage could be gained assessing each cover type separately.

e. Estimate the change in productivity in the conflict zones. It was estimated by the Lake Ilo National Wildlife Refuge manager (Dinkins, pers. comm.) that the 6,000-acre refuge, including 1,000 acres of water and about 5,000 acres of land, maintains 13 deer/mi². Discounting for the water area gives an estimate of 13 deer/533 acres or 0.024 deer/acre. Using this as a mean productivity estimate, the 339 acres in the conflict zone would have an estimated productivity of eight deer. Assuming a 50 percent decline in habitat value due to behavioral avoidance, the urban development would result in habitat productivity loss of four deer in the designated conflict zone.

Only the 1987 estimates for land use conversion were prepared. Since the Dunn Center area was the only community identified as having a land use/wildlife habitat conflict, and the number of in-migrants to Dunn Center was expected to peak in 1987, it was assumed that this would also represent the most critical phase for land use conversions.
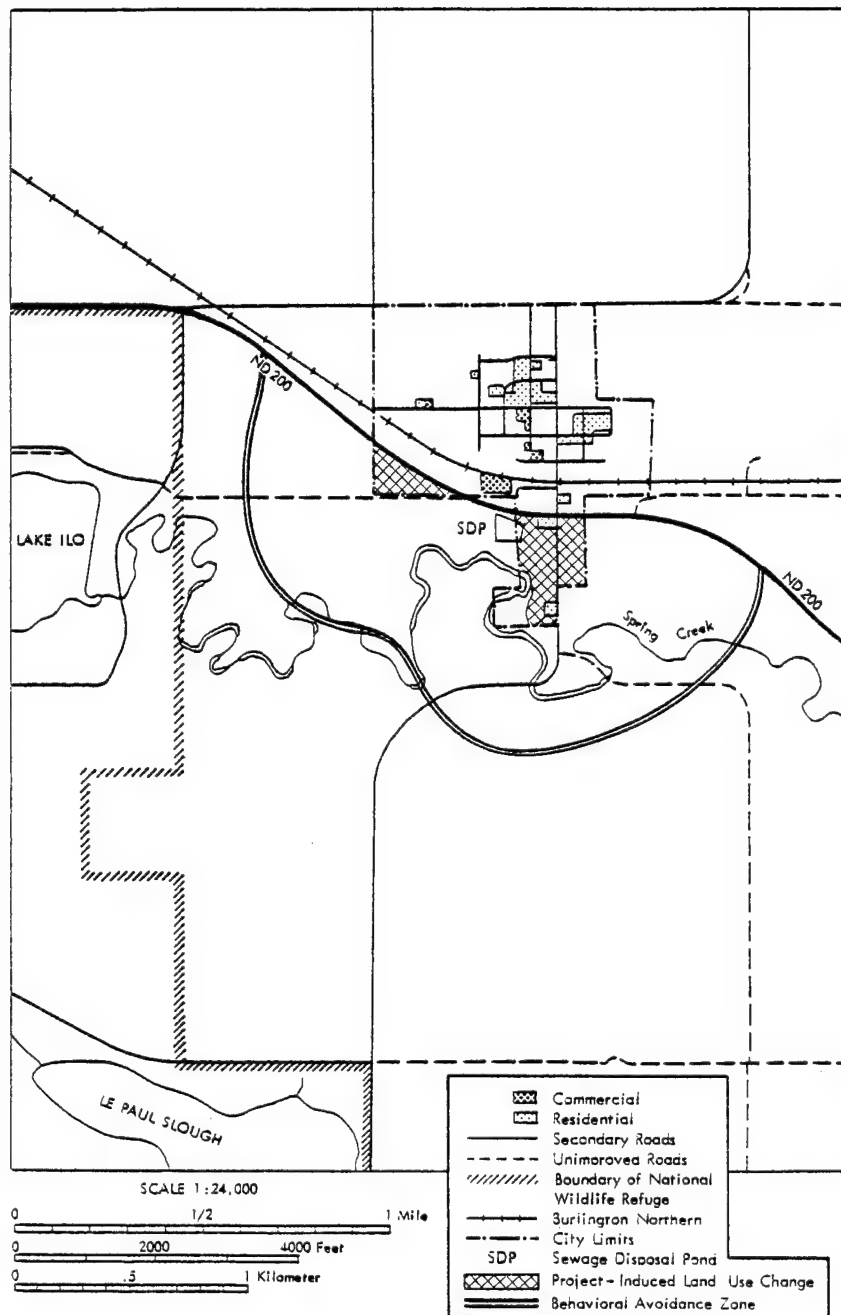
Figure 14. Behavioral avoidance zone south of land use conversion
areas in Dunn Center

179

Sample Worksheet No. 2

LAND USE IMPACT ASSESSMENT

Step 1 - Setting Priorities

    a. Minimize loss of native prairie, wetland, riparian, and woodland.

    b. Minimze disturbance to Lake Ilo National Wildlife Refuge habitat.

Step 2 - Identifying Potential Conflicts

                                                           Yes   No

a.   Around communities or community spheres of influence: _x_ ___

        If yes, list communities of primary concern: ___ Dunn Center ___

                                                           Yes   No

b.   Along proposed developments (highway, railway, power line, ___ _x_
        or other corridors)

        If yes, list developments of concern:

                                     Yes   No

c.   On rural county or public lands: ___ _x_

        If yes, list counties and locations of concern: _____

180

Step 3 - Projecting Land Use Conversions

Community: <u>Dunn Center</u>   Year   <u>1987</u>

	Construction workers		Operation workers		Secondary workers	
1. <u>Type of housing:</u>	Standard values	Your values	Standard values	Your values	Standard values	Your values
Single family house	15%	15%	60%		40%	
Apartment	10	5%	20		33	
Mobile homes	60	55%	20		27	
Other (e.g., motels, RVs, mancamps, sleeping rooms)	15	25%	0		0	
Total	100%	100%	100%		100%	

	Construction workers	Operation workers	Secondary workers
2. Total in-migrating workers (from Worksheet 1, Step 3)	2,471 (line 5)	260 (line 10)	1,151 (line 21)
3. Community share (from Worksheet 1, Step 5a)	x .05	x .12	x .03
4. Number of worker households	= 124	= 31	= 35

181

Community: <u>Dunn Center</u>   Year   <u>1987</u>

	Construction workers			Operation workers			Secondary workers			5. Total housing
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	
House	.15 x	124 =	19	.60 x	31 =	19	.40 x	35 =	14	52
Apartment	.05 x	124 =	6	.20 x	31 =	6	.33 x	35 =	12	24
Mobile home	.55 x	124 =	68	.20 x	31 =	6	.27 x	35 =	9	83
Other	.25 x	124 =	31	0 x	31 =	0	0 x	35 =	0	31
5. Total housing	1.00 x	124 =	124	1.00 x	31 =	31	1.00 x	35 =	35	190

(a) = Percent by unit type, line 1

(b) = Number of workers households, line 4

(c) = Units

	Total units (from line 5)		6. Units per acre		7. Acres
Houses	52	÷	$\frac{\text{range}}{(4-0.2)}$	4 =	13
Apartments	24	÷	$\frac{\text{range}}{(8-15)}$	8 =	3
Mobile Homes	83	÷	$\frac{\text{range}}{(8-15)}$	8 =	10
Other Units	31	÷	$\frac{\text{range}}{(15-20)}$	20 =	2
8. Subtotal					28

Land requirements for other urban uses

9. Total in-migrants (from Worksheet 1, Step 5b)   459
                                                        ÷ 1000
                                          10.   =   .459

   Acres per 1,000 new population, other urban uses   x 38.75

11. Acres, excluding housing, streets, and   =   18
       rights-of-way

                                                x   1.3

12. Acres for streets and rights-of-way   =   23

13. Subtotal, acres for all nonhousing uses   =   41
       (lines 11 + 12)

14. Housing acres (subtotal, line 8)   +   28

15. Total acres   =   69

16. Compute any other land use conversions

                                            Year: 1987

        (Location)   (std)   (acres)   (notes)

   Utility _____   _____   0   _____
   Roads   _____   _____   0   _____
   Satellite developments: 0

   _____   _____   _____   _____

   _____   _____   _____   _____

                          Subtotal =   0

17. Total acres, all conversions
       (Lines 15 + 16)   =   69

Steps 4, 5, and 6 - See accompanying text and maps.

HUNTING IMPACT ASSESSMENT

Step 1

The impact area offers two types of big game hunting--deer and turkey--plus several species of upland game, the normal complement of waterfowl, and two primary furbearers. Firearms deer hunting as well as turkey hunting are restricted through lottery. All other hunting in the area is available to anyone on an unrestricted basis. Completion of this step is relatively straightforward, the only data needed being current State hunting regulations.

Step 2

Data were available, on computer files, for restricted licenses. Computer file data also allowed calculation of user profiles by place of residence, home county in this case. It should be noted that for deer, the profile data included only local residents who applied for local units. Those outside the impact area who applied for units were excluded. While it was likely that the age and sex ratios and participation rates were not different between these two populations, since this degree of disaggregation was readily available it was used in the example.

Completion of Step 2 for small game required use of State-level data, which were also available on computer tape from the State university. In this case it was fortunate to have available an ad hoc study of hunter and fishermen expenditures in the State. The next best alternative would have been the North Dakota volume of the National survey. In using State data, it was assumed that both county residents and in-migrants would participate in these activities at State-level rates. The rates may be unavoidably biased somewhat by the more rural nature of Dunn and Mercer Counties compared to the State. Also, the female category for small game was not disaggregated by age; the participation rate was so low that disaggregation was not judged to be crucial to the outcome. State-level data were also used to develop profiles of furbearer hunting participants.

Some problems in completing Step 2 might be:

1. Unavailability of county level data.

2. Inconsistency between game management units and boundaries of census units.

3. Residents who hunt outside of their home area.

4. Nonresidents who hunt within the impact area.

Step 3

The number of in-migrants from the demographic impact assessment worksheet is multiplied by the participation ratio to arrive at the number of new participants. Potential added days of participation are derived using

184

an annual days per participant estimate for that activity. The outcome is quite sensitive to the choice of an estimate of average number of days per participant. State or area data should be used, and ranges can be added to the calculation at this step. For example, in this instance the estimates of average number of days per participant for hunting deer (firearms) varied from 5 days (National survey) to 3.7 days (Kerestes 1982).

Estimating upland game and small game hunting presented some difficulty because in North Dakota such hunting also includes waterfowl insofar as licensing is concerned. Sources indicated that 72 percent of the small game licensees hunted waterfowl and 78 percent hunted upland game. These categories were further apportioned by individual species.

Step 4

The first part of Step 4 summarizes Step 3 data. In this example, potential additional demand was found to be approximately equal to current local demand. Several effects of this 100 percent increase were predicted by local resource managers.

While Step 4 presents additional demand, we do not have estimates of supply. If there currently exists excess capacity equal to or greater than the additional demand, there should be no problem. The Game and Fish Department implies by unrestricted license sales that supply of these species is adequate to meet demand, or that demand may be managed in other ways such as shorter seasons or bag limits. However, in the case of restricted licenses in the deer unit where demand already exceeds supply the problem will become more serious.

Step 4b was used because the area did have two hunting categories where the number of licenses available is restricted. There are three deer hunting units that overlap the study area. One has had more applicants than available licenses while the other two have had surplus licenses in recent years. (Local resource managers should be able to identify the reasons behind this. It could be lack of game, shortage of land to hunt on, lack of information by hunters, or other reasons. The impact of projected additional applicants will need to be tempered with this type of local knowledge.) Changes in odds of selection for deer-firearms permits and turkey hunting permits were calculated.

In conclusion, this case study showed that both quantitative and qualitative impact of in-migrants to Dunn and Mercer Counties are expected to be significant. Projections for 1987 indicate a twofold increase in local population, which will in turn lead to a disproportionate increase in the demand for hunting recreation due to the atypical population structure.

Hunting for species for which there are limited permits will become more competitive. By 1987, the odds for being selected for a turkey hunting permit will decline from 1:2.6 to 1:3.1, leaving approximately 120 additional turkey hunters unsatisfied. Similarily, for deer hunting with firearms the odds will decline from almost 1:1 to 1:0.75. This will leave roughly 1,100 potential deer hunters unsatisfied. The end result will be

some shifting of hunting choices by hunters. Shifting is limited by available land, tradition, and distance to travel, however. In the long run it is expected that the odds for being selected will decline but that some shifting of applications will occur to spread the burden and lessen the impact on the local units.

Small game hunting, including upland species and waterfowl, will be affected primarily by the crowding that will occur. Crowding has two impacts. First, it makes the experience less desirable. Second, it imposes an increased nuisance burden on local landowners which may lead to reduced access to private lands. There appears to be an adequate supply of game birds and animals to handle the increased demand in hunter activity days; if not, bag limits or seasons will be adjusted. Deteriorated hunting conditions will cause some locals and in-migrants either to quit hunting or to shift to other less crowded areas. The end result may be a slightly reduced hunting quality, some individuals dropping out of the activity, and an increased level of posting of private lands.

Furbearer or predator hunting will feel the impact of hundreds of additional participants. Like the other activities, these impacts will be spread over a larger area than just the two-county impact area, which will lessen the local impact. The availability of furbearers and the demand for them is closely tied to fur prices. Thus, as prices go up more demand is put on the resource. Conversely, as prices go down or the resource becomes scarce due to high prices, interest falls off. Increased furbearer hunting should have little impact on furbearer trapping. Few of the in-migrants are expected to become trappers. Compared to trappers, furbearer hunters take a relatively small portion of furbearers.

Sample Worksheet No. 3

HUNTING IMPACT ASSESSMENT

Step 1 - Identify Locally Available Wildlife Hunting Opportunities and Required Licenses.

County/Area_____Dunn and Mercer Counties_____

		species	license/license availability
A.	Big game:	Deer--firearms	restricted by unit
		Turkey	restricted by unit
		Deer--archery	unlimited
B.	Upland game/ small game:	Sharp-tailed grouse	
		Ring-neck pheasant	
		Hungarian partridge	
		Squirrel	unlimited
		Rabbit	
		Mourning dove	
C.	Waterfowl:	Ducks & geese	unlimited (Federal Duck Stamp)
D.	Furbearer/ predator:	Fox	unlimited
		Coyote	

Note: A general game license is a prerequisite to the purchase of any other North Dakota hunting license.

187

<u>Step 2</u> - Develop a Profile of Current Resident Licensees

Impact area___<u>Dunn and Mercer Counties</u>___
License type <u>Deer-firearms</u>_____
Data by: license _____√_____
         activity _____

List resident license holders by age and sex category.

Males

Age group[a]	County population[b]	Number of applicants	Participation ratio	Notes[c]
< 12	1,434	0	0.000	
12-14	375	31	0.083	Mittleider et al. (1980):
15-17	396	69	0.174	Big game all age/sex =
18-19	229	62	0.271	1985: 0.096
20-24	714	185	0.259	1997: 0.097
25-34	1,231	397	0.323	Harmoning (pers. comm.):
35-44	815	172	0.211	0.113
45-64	1,363	147	0.108	These ratios represent
> 64	712	24	0.034	only local applicants
	7,269	1,087	0.149	for local units.

Females

Age group	County population	Number of applicants	Participation ratio
< 12	1,405	0	0.000
12-14	345	0	0.000
15-17	417	2	0.005
18-19	178	6	0.034
20-24	578	29	0.050
25-34	1,069	67	0.063
35-44	654	28	0.043
45-64	1,286	16	0.012
> 64	781	0	0.000
	6,713	148	0.022

---

[a] Do not aggregate ages until completion of Step 3.

[b] From census data or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.

[c] Mittleider et al. (1980) projects that 9.6% of the SR7 1985 population will participate in deer hunting. Harmoning (pers. comm.) reported that 11.3% of the State's population applied for firearm deer permits in 1982. These two estimates are noticeably less than the 14+% found in the local area. This is, of course, due to the rural nature of the impact area. Rural residents are more likely to apply for deer hunting permits due to greater knowledge of the resource, availability of land, background, and similar factors than are residents of the State's larger cities (e.g., Fargo and Grand Forks).

Data Sources <u>State Game and Fish</u>
                 <u>Dept.; State University</u>

188

Step 3 - Applying Participation Rates (1987)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1987</u>
License or activity type <u>Deer-firearms</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of In-migrants[a]	Participation ratio	Potential new applicants	Notes
< 12	1,168	0.000	0	Some of these new
12-14	197	0.083	16	applicants may
15-17	164	0.174	29	apply for other
18-19	52	0.271	14	than local units.
20-24	872	0.259	226	
25-34	1,679	0.323	542	
35-44	608	0.211	128	
45-64	625	0.108	68	
> 64	0	0.034	0	
	5,365		1,023	

Females

Age group	Number of In-migrants	Participation ratio	Potential new applicants	
< 15	1,365	0.000	0	
15-17	164	0.005	1	
18-19	52	0.034	2	
20-24	555	0.050	28	
25-34	1,124	0.063	71	
35-44	394	0.043	17	
45-64	375	0.012	5	
> 64	0	0.000	0	
	4,029		124	

TOTAL Potential new applicants <u>1,147</u>
Days per participant <u>3.7</u>
Total potential added demand <u>4,244</u>

[a]From Worksheet No. 1, Step 4, Population Summary.

Step 3 - Applying Participation Rates (1994)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1994</u>
License or activity type <u>Deer-firearms</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants or applicants	Notes
< 12	717	0.000	0	
12-14	129	0.083	11	
15-17	92	0.174	16	
18-19	24	0.271	7	
20-24	335	0.259	87	
25-34	885	0.323	286	
35-44	281	0.211	59	
45-64	186	0.108	20	
> 64	0	0.034	0	
	2,649		486	

Females

Age group	Number of in-migrants	Participation ratio	Potential new participants or applicants	Notes
< 15	846	0.000	0	
15-17	92	0.005	0	
18-19	24	0.034	1	
20-24	300	0.050	15	
25-34	788	0.063	50	
35-44	251	0.043	11	
45-64	166	0.012	2	
> 64	0	0.000	0	
	2,467		79	

TOTAL Potential new licenses/applicants	565
Days per participant	3.7
Total potential added demand	2,091

[a]From Worksheet No. 1, Step 4, Population Summary.

Step 2 - Developing a Profile of Current Resident Licensees

State/County/Unit <u>North Dakota</u>
License Type <u>Deer-archery</u>
Data on License <u>   √   </u>
Data by Activity <u>   </u>

List resident license holders by age/sex category.

Males

Age group[a]	State population[b]	Number of licenses	Participation ratio	Notes[c]
< 12	63,866	0	0.0000	No other archery
12-14	15,751	36	0.0023	deer partici-
15-17	18,439	608	0.0330	pation data
18-19	14,481	358	0.0247	available.
20-24	35,889	1,932	0.0538	
25-34	54,660	4,078	0.0746	
35-44	32,279	1,216	0.0377	
45-64	57,578	536	0.0093	
> 64	35,483	0	0.0000	
	328,426	8,764	0.0267	

Females

All	324,291	107	0.0003	

All age/sex groups: 0.0136

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[a] Do not aggregate ages until completion of Step 3.
[b] From census data or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.
[c] Include participation ratios from other sources.

Sources: <u>Kerestes 1982</u>

Step 3 - Applying Participation Rates (1987)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1987</u>
License or activity type <u>Deer-archery</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants	Notes
< 12	1,168	0.0000	0	
12-14	197	0.0023	0	
15-17	164	0.0330	5	
18-19	52	0.0247	1	
20-24	872	0.0538	47	
25-34	1,679	0.0746	125	
35-44	608	0.0377	23	
45-64	625	0.0093	6	
> 64	0	0.0000	0	
	5,365		207	

Females

All	4,029	0.0003	1

TOTAL Potential new licenses	208	
Days per participant	11.7 to 12.9	
Total potential added demand	2,434 to 2,683	

[a]From Worksheet No. 1, Step 4, Population Summary.

192

Step 3 - Applying Participation Rates (1994)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1994</u>
License type <u>Deer-archery</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants	Notes
< 12	717	0.0000	0	
12-14	129	0.0023	0	
15-17	92	0.0330	3	
18-19	24	0.0247	1	
20-24	335	0.0538	18	
25-34	885	0.0746	66	
35-44	281	0.0377	11	
45-64	186	0.0093	2	
> 64	0	0.0000	0	
	2,649		101	

Females

All	2,467	0.0003	1

TOTAL Potential new licenses	102	
Days per participant	11.7	12.9
Total potential added demand	1,193	1,316

[a]From Worksheet No. 1, Step 4, Population Summary.

193

Step 2 - Developing a Profile of Current Resident Licensees

Impact area <u>Dunn and Mercer Counties</u>
License type <u>Turkey</u>
Data on license <u> √ </u>
Data by activity <u>   </u>

List resident license holders by age/sex category.

Males

Age groups[a]	Unit 13[b]	Number of applicants	Participation ratio	Notes[c]
< 15	1,859	4	0.002	This represents only
15-17	396	9	0.023	resident appli-
18-19	229	4	0.017	cants for Unit 13.
20-24	714	12	0.017	There were 653
25-34	1,231	34	0.028	total applicants
35-44	815	19	0.023	for 250 available
45-64	1,363	21	0.015	permits.
> 64	712	6	0.008	No other participa-
	7,319	109	0.015	tion estimates
				were available.

Statewide 0.013

Females

All	6,712	37	0.006	

Statewide 0.001

---

[a] Do not aggregate ages until completion of Step 3.
[b] From census data or other available source. Use closest divisions that
   coincide with available license data and demographic profiles of in-
   migrants.
[c] Include participation ratios from other sources.

Sources: <u>Harmoning (pers. comm.)</u>

194

Step 3 - Applying Participation Rates (1987)

Impact area Dunn and Mercer Counties
Year 1987
License type Turkey

List in-migrants by age/sex category using data from demographic profiles.

Males

Age groups	Number of in-migrants[a]	Participation ratio	Potential new applicants	Notes
< 15	1,365	0.002	3	
15-17	164	0.023	4	
18-19	52	0.017	1	
20-24	872	0.017	15	
25-34	1,679	0.028	47	
35-44	608	0.023	14	
45-64	625	0.015	9	
> 64	0	0.008	0	
	5,365		93	

Females

All	4,029	0.006	24	

TOTAL Potential new applicants	117	
Days per participant	2	
Total potential added demand	234	

[a]From Worksheet No. 1, Step 4, Population Summary.

Step 3 - Applying Participation Rates (1994)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1994</u>
License type <u>Turkey</u>

List in-migrants by age/sex category using data from demographic profiles.

<center>Males</center>

Age group	Number of in-migrants[a]	Participation ratio	Potential new applicants	Notes
< 15	846	0.002	2	
15-17	92	0.023	2	
18-19	24	0.017	0	
20-24	335	0.017	6	
25-34	885	0.028	25	
35-44	281	0.023	6	
45-64	186	0.015	3	
> 64	0	0.008	0	
	2,649		44	

<center>Females</center>

All	2,467	0.006	15	

TOTAL Potential new applicants	59	
Days per participant	2	
Total potential added demand	118	

[a]From Worksheet No. 1, Step 4, Population Summary.

Step 2 - Developing a Profile of Current Resident Licensees

State/County/Unit <u>North Dakota</u>
License Type <u>Small game</u>
Data on License <u>√</u>
Data by Activity <u> </u>

List resident license holders by age/sex category.

<p align="center">Males</p>

Age group[a]	State population[b]	Number of licensees	Participation ratio	Notes[c]
< 15	79,617	12,284	0.154	
15-17	18,439	5,104	0.277	Mittleider et al.
18-19	14,481	1,856	0.128	(1980): all
20-24	35,889	8,505	0.237	Upland game -
25-34	54,660	21,339	0.390	0.1420
35-44	32,279	9,587	0.297	Waterfowl - 0.0628
45-64	57,578	10,980	0.191	U.S. Dept. of the
> 64	35,483	3,092	0.087	Interior and U.S.
	328,426	72,747	0.222	Dept. of Commerce 1982.:
				Upland game - 0.126
				Waterfowl - 0.078

<p align="center">Females</p>

15-64	204,135	885	0.004	

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[a] Do not aggregate ages until completion of Step 3.
[b] From census data or other available source. Use closet divisions that coincide with available license data and demographic profiles of in-migrants.
[c] Include participation ratios from other sources.

Sources: <u>Kerestes 1982, U.S. Bureau of the Census 1980</u>

Step 3 - Applying Participation Rates (1987)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1987</u>
License type <u>Small game</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants	Notes
< 15	1,365	0.154	210	72% hunt waterfowl
15-17	164	0.277	45	an average of
18-19	52	0.128	7	9 days
20-24	872	0.237	207	78% hunt upland
25-34	1,679	0.390	655	game an average
35-44	608	0.297	181	of 13 days
45-64	625	0.191	119	
> 64	0	0.087	0	
	5,365		1,424	

Females

All	4,029	0.004	16	
			1,440	

Waterfowl   0.72 x 1,440 = <u>1,037</u> x 9 days = <u>9,333 days</u>

    Ducks   0.52 x 9,333 = 4,853
    Geese   0.46 x 9,333 = 4,293
    Other   0.02 x 9,333 =   187
                                9,333 days

Upland game   0.78 x 1,440 = <u>1,123</u> x 13 days = <u>14,599 days</u>

    Sharp-tailed grouse   0.20 x 14,599 = 2,920
    Hungarian partridge   0.28 x 14,599 = 4,088
    Pheasant   0.26 x 14,599 = 3,791
    Squirrel   0.02 x 14,599 =   292
    Rabbit   0.07 x 14,599 = 1,022
    Doves   0.13 x 14,599 = 1,898
    Other   0.04 x 14,599 =   584
                                14,600 days

		Waterfowl	Upland
TOTAL Potential new participants	1,440		
Days per participant		9	13
Total potential added demand		9,333 days	14,599 days

[a]From Worksheet No. 1, Step 4, Population Summary.

<u>Step 3</u> - Applying Participation Rates (1994)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1994</u>
License type <u>Small game</u>
List in-migrants by age/sex category using data from demographic profiles.

<div align="center">Males</div>

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants	Notes
< 15	846	0.154	130	72% hunt water-
15-17	92	0.277	25	fowl for an
18-19	24	0.128	3	average of 9 days
20-24	335	0.237	79	
25-34	885	0.390	345	
35-44	281	0.297	83	78% hunt up-
45-64	186	0.191	36	land game for an
> 64	0	0.087	0	average of 13 days
	2,649		701	

<div align="center">Females</div>

All	2,467	0.004	10	
			711	

Waterfowl $\quad$ 0.72 x 711 $\quad = \quad \underline{512}$ x 9 days = <u>4,608 days</u>

$\quad\quad$ Ducks $\quad$ 0.52 x 4,608 = 2,396
$\quad\quad$ Geese $\quad$ 0.46 x 4,608 = 2,120
$\quad\quad$ Other $\quad$ 0.02 x 4,608 = $\quad$ 92
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ 4,608 days

Upland game $\quad$ 0.78 x 711 $\quad = \underline{555}$ x 13 days = <u>7,215 days</u>

$\quad\quad$ Sharp-tailed grouse $\quad$ 0.20 x 7,215 = 1,443
$\quad\quad$ Hungarian partridge $\quad$ 0.28 x 7,215 = 2,020
$\quad\quad$ Pheasant $\quad$ 0.26 x 7,215 = 1,876
$\quad\quad$ Squirrel $\quad$ 0.02 x 7,215 = $\quad$ 144
$\quad\quad$ Rabbit $\quad$ 0.07 x 7,215 = $\quad$ 505
$\quad\quad$ Doves $\quad$ 0.13 x 7,215 = $\quad$ 938
$\quad\quad$ Other $\quad$ 0.04 x 7,215 = $\quad$ 289
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ 7,215 days

	TOTAL Potential new participants	711	
		Waterfowl	Upland
	Days per participant	9	13
	Total potential added demand	4,608 days	7,215 days

[a]From Worksheet No. 1, Step 4, Population Summary.

<u>Step 2</u> - Developing a Profile of Current Resident Licensees

State/County/Unit <u>North Dakota</u>
License Type <u>Furbearers</u>
Data on License   <u> √ </u>
Data by Activity <u>   </u>

List resident license holders by age/sex category.

<center><u>Males</u></center>

Age group[a]	State population[b]	Number of licensees	Participation ratio	Notes[c]
< 12	63,866	0	0.000	Mittleider et al.
12-14	15,751	430	0.027	(1982): Both sexes
15-17	18,439	2,350	0.127	1985: 0.0826
18-19	14,481	2,360	0.163	1995: 0.0865
20-24	35,889	5,340	0.149	National Survey:
25-34	54,660	11,110	0.203	0.0542 = N.D.
35-44	32,279	5,980	0.185	over age 16
45-64	57,578	3,630	0.063	
> 64	35,483	850	0.024	
	328,426	32,050	0.098	

<center><u>Females</u></center>

All	324,291	400	0.001

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[a] Do not aggregate ages until completion of Step 3.
[b] From census data or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.
[c] Include participation ratios from other sources.

Sources   <u>Kerestes 1982, U.S. Bureau of the Census 1980,</u>
                <u>Mittleider et al. 1980</u>

<u>Step 3</u> - Applying Participation Rates (1987)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1987</u>
License type <u>Furbearer</u>

List in-migrants by age/sex category using data from demographic profiles.

<div align="center">Males</div>

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants or applicants	Notes
< 12	1,168	0.000	0	Mittleider
12-14	197	0.027	5	et al.
15-17	164	0.127	21	(1980):
18-19	52	0.163	8	1987 = 222
20-24	872	0.149	130	U.S. Dept.
25-34	1,679	0.203	341	of the
35-44	608	0.185	112	Interior
45-64	625	0.063	39	and U.S.
> 64	0	0.024	0	Dept. of
	5,365		656	Commerce
				(1982):212

<div align="center">Females</div>

All	4,029	0.001	4	

TOTAL Potential new licenses/applicants	660		
		Fox	Coyote
Days per participant		11.5	10.2
Total potential added demand		5,693	2,825

	Days	% Licensees participating
Kerestes (1982):		
Fox Days	11.5	0.75
Coyote Days	10.2	0.42
	NA	NA
Harmoning (pers. comm.):		
Fox Days	11.6	NA
Coyote Days	9.5	NA
U.S. Dept. of the Interior and U.S. Dept. of Commerce (1982):		
All	13	NA

[a]From Worksheet No. 1, Step 4, Population Summary.

Step 3 - Applying Participation Rates (1994)

Impact area <u>Dunn and Mercer Counties</u>
Year <u>1994</u>
License type <u>Furbearer</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants[a]	Participation ratio	Potential new participants or applicants	Notes
< 12	717	0.000	0	
12-14	129	0.027	3	
15-17	92	0.127	12	
18-19	24	0.163	4	
20-24	335	0.149	50	
25-34	885	0.203	180	
35-44	281	0.185	52	
45-64	186	0.063	12	
> 64	0	0.024	0	
	2,649		313	

Females

All	2,467	0.001	2	

		Fox	Coyote
TOTAL Potential new licenses/applicants	315		
Days per participant		11.5	10.2
Total potential added demand		2,714	1,346

[a]From Worksheet No. 1, Step 4, Population Summary.

202

Step 4 - Summarizing Additional Participation and Potential Demand Changes

Impact area <u>Dunn and Mercer Counties</u>

License type	Year: 1987 Participants	Days	Other Impacts	Year: 1994 Participants	Days	Other impacts
A. Big game						
Deer, Firearms	1,147	4,244	A,B,C	565	2,091	A,B,C
Deer, Archery	208	2,434		102	1,193	
Turkey	117	234	C	59	118	C
B. Small game/ upland game	1,440	14,599	A,B	711	7,215	A,B
Sharp-tailed grouse		2,920			1,443	
Hungarian partridge		4,088			2,020	
Pheasant		3,796			1,876	
Squirrels		292			144	
Rabbits		1,022			505	
Doves		1,898			938	
Others		584			289	
C. Waterfowl	1,037	9,333	D	512	4,608	
Ducks		4,853			2,396	
Geese		4,293			2,120	
Others		187			92	
D. Furbearers/ Predators	660		F	315		
Fox		5,693			2,714	
Coyote		2,825			1,346	
Others		NA			NA	
Total	4,609			2,264		

<u>Step 4b</u> - Estimating the Effect of In-migrant Demand for Restricted Licenses on the Chances of Obtaining a Restricted License

County/Area <u>Dunn and Mercer Counties</u>   Year <u>1987</u>

1.   License type <u>Firearms-Deer</u>

    Local applicants[a] <u>   1,081   </u>

    Nonlocal applicants[b] <u>   499   </u>   In-migrant applicants[c] <u> 1,147 </u>

    Licenses available <u>   1,564   </u>

    Odds of selection <u>   0.99   </u>   Odds including in-migrants <u>0.57</u>

This is for three combined deer management units. Only one unit is currently experiencing more applicants than available permits; the other two have had leftover permits.

2.   License type <u>Turkey</u>

    Local applicants <u>   109   </u>

    Nonlocal applicants <u>   544   </u>   In-migrant applicants <u>   117   </u>

    Licenses available <u>   250   </u>

    Odds of selection <u>   0.38   </u>   Odds including in-migrants <u>0.33</u>

---

[a]The number of local applicants for the local hunting unit should be used rather than the total number of local applicants, since some locals may apply for another hunting unit.
[b]Applicants for local unit, but from outside the area should be included.
[c]The number of in-migrant applicants should be adjusted for those who applied for this unit previously and those who apply for other units instead of the local unit.

<u>Step 4b</u> - Estimating the Effect of In-migrant Demand for Restricted Licenses on
the Chances of Obtaining a Restricted License

County/Area <u>Dunn and Mercer Counties</u>   Year <u>1994</u>

1.   License type <u>Firearms Deer</u>

    Local applicants[a] <u>   1,159   </u>

    Nonlocal applicants[b] <u> 535 </u>   In-migrant applicants[b] <u> 565 </u>

    Licenses available <u> 1,564 </u>

    Odds of selection <u> 0.92 </u>   Odds including in-migrants <u>0.69</u>

2.   License type <u>Turkey</u>

    Local applicants <u> 117 </u>

    Nonlocal applicants <u> 583 </u>   In-migrant applicants <u> 49 </u>

    Licenses available <u> 250 </u>

    Odds of selection <u> 0.36 </u>   Odds including in-migrants <u>0.33</u>

---

[a]Assumes 1% annual growth rate.
[b]The number of in-migrant applicants should be adjusted for those who ap-
plied for this unit previously and those who apply for other units in-
stead of the local unit.

FISHING IMPACT ASSESSMENT

Step 1

For the Dunn County example, eight species of interest and three fishing sites were identified.

Step 2

Data were available from computer files on participation by age category. In some categories, data were supplemented using statistics from the National survey.

Step 3

Projections for fishing demand in 1987 and 1994 by new residents were developed using the participation ratios developed in Step 2 and the data on in-migrants produced in Worksheet 1. State estimates on days per participant were used.

Step 4

Additional days per species were estimated using Step 3 results distributed across the eight species identified in Step 1.

The overall impact of energy development in Dunn and Mercer counties on fishing activity will be slight. The primary fishing location is the 500,000-acre Garrison Reservoir. It currently supports very large populations of sport fish. One adverse impact on quality of the fishing experience will be crowding at boat launching sites and associated water-based recreation facilities such as campgrounds. This could be alleviated by constructing additional launching sites and camping areas. The fishery will, however, support the additional potential demand at its current production level.

Lake Ilo, near Dunn Center, may require increased levels of fish stocking. Lake Ilo is already fished quite heavily, and the added demand will necessitate more stocking in order to meet those needs. The major sport fishery at the lake is walleyed pike.

Sample Worksheet No. 4

FISHING IMPACT ASSESSMENT

Step 1 - Identifying Locally Available Fishing Opportunities

County/Area Dunn and Mercer Counties

Species	Distribution of fishing time	Local fishing sites
Walleye	0.34	L. Sakakawea, Knife River, Lake Ilo
Northern pike	0.28	L. Sakakawea, Knife River, Lake Ilo
Trout	0.10	L. Sakakawea, Knife River, Lake Ilo
Panfish	0.10	L. Sakakawea, Knife River, Lake Ilo
Paddlefish	0.01	L. Sakakawea, Knife River, Lake Ilo
Salmon	0.03	L. Sakakawea, Knife River, Lake Ilo
Catfish	0.02	L. Sakakawea, Knife River, Lake Ilo
Bass	0.05	L. Sakakawea, Knife River, Lake Ilo
Anything	0.07	L. Sakakawea, Knife River, Lake Ilo
	1.00	

Source(s): Kerestes 1982

Step 2 - Developing a Profile of Current Resident Licensees

State/County/Unit <u>North Dakota</u>

License type <u>Fishing</u>   Data by: license ____√____

Data source(s) <u>U.S. Dept. of the Interior</u>   activity _____
<u>and U.S. Dept. of Commerce</u>
<u>1982, Harmoning (pers. comm.),</u>
<u>Bureau of the Census 1980</u>

List resident license holders by age/sex category.

Males

Age group[a]	Impact area resident population[b]	Number of applicants	Participation ratio	Notes[c]
69% < 16	No license required		0.20	
16-17			0.43	
18-24			0.36	
25-34	$=$	44,070	0.42	
35-44			0.42	
45-54			0.34	
55-64			0.29	
> 65	Senior citizen license 11,863		0.22	

Females

31% < 16			0.10	
16-17			0.13	
18-24			0.17	
25-34	$=$	44,070	0.21	
35-44			0.17	
45-54			0.15	
55-64			0.14	
> 65		5,284	0.06	
		105,287	0.38	

a Do not aggregate ages until completion of Step 3.
b From census or other available source. Use closest divisions that coincide with available license data and demographic profiles of in-migrants.
c Include participation ratios from other sources.

Step 3 - Estimating the Potential Number of In-migrants Who Will Fish

Impact Area <u>Dunn and Mercer Counties</u>   Year <u>1987</u>   License Type <u>Fishing</u>

List in-migrants by age/sex category using data from demographic profiles.

Males

Age group	Number of in-migrants	Participation ratio	Potential new participants	Notes
< 16	1,420	0.20	284	
16-17	109	0.43	47	
18-24	924	0.36	333	
25-34	1,679	0.42	705	
35-44	608	0.42	255	
45-54 55-64	} 625	} 0.31	} 194	
> 64	0	0.22	0	
	5,365		1,818	

Females

< 16	1,420	0.10	142	
16-17	109	0.13	14	
18-24	607	0.17	103	
25-34	1,124	0.21	236	
35-44	394	0.17	67	
45-54 55-64	} 375	} 0.14	} 53	
> 64	0	0.06	0	
	4,029		615	

TOTAL Potential new licensees <u>2,433</u>
Annual days per participant <u>7.0</u>
Total potential added demand <u>17,031</u>

Source(s): <u>Days/participant > 7.0 (Mittleider et al. 1980)</u>.

209

<u>Step 3</u> - Estimating the Potential Number of In-migrants Who Will Fish

Impact Area <u>Dunn and Mercer Counties</u>   Year <u>1994</u>   License Type <u>Fishing</u>

List in-migrants by age/sex category using data from demographic profiles.

<div align="center"><u>Males</u></div>

Age groups	Number of in-migrants	Participation ratio	Potential new participants	Notes
< 16	877	0.20	175	
16-17	61	0.43	26	
18-24	359	0.36	129	
25-34	885	0.42	372	
35-44	281	0.42	118	
45-64	186	0.31	58	
> 64	0	0.22	0	
	2,649		878	

<div align="center"><u>Females</u></div>

Age groups	Number of in-migrants	Participation ratio	Potential new participants	Notes
< 16	877	0.10	88	
16-17	61	0.13	8	
18-24	324	0.17	55	
25-34	788	0.21	165	
35-44	251	0.17	43	
45-64	166	0.14	23	
> 64	0	0.06	0	
	2,467		382	

TOTAL Potential new license applicants   1,260
Annual days per participant   7.0
Total potential added demand   8,820

<u>Step 4</u> - Estimating the Potential Additional Fishing Days and Distributing Days by Species

| Species | Distribution of fishing time | Additional days demanded | | Other considerations[a] |
		1987	1994	
Walleye	0.34	5,791	2,999	A
Northern pike	0.28	4,769	2,470	A,B
Trout	0.10	1,703	882	A
Panfish	0.10	1,703	882	A
Paddlefish	0.01	170	88	A
Salmon	0.03	511	265	A
Catfish	0.02	341	176	A
Bass	0.05	852	441	A
Anything	0.07	1,192	617	A
	1.00	17,031	8,820	A

---

[a] Other considerations include:

  A = Bottleneck or constraint at access points is probable (e.g., boat
        land ramps).
  B = Species supply at some locations will be a constraint.
  C = Other: <u>None</u>
  D = No constraints anticipated.

WILDLIFE-RELATED NONCONSUMPTIVE RECREATION IMPACT ASSESSMENT

Step 1

Participation in primary, nonresidential activities was of greatest interest in the Dunn County example since the Lake Ilo National Wildlife Refuge is so near to the communities of Killdeer and Dunn Center which are both expected to receive a significant population increase. Primary, non-residential nonconsumptive use of wildlife is considered to include any days spent on trips or outings of at least 1 mile taken for the primary purpose of observing, photographing, or feeding wildlife. Participation ratios were taken from the National Survey but State data will soon be available for use instead.

Step 2

Since the peak year total regional in-migration was desired (Dunn County plus Mercer County), only the 1987 population summary (Step 4, Worksheet No. 1) was used to estimate in-migrants. Where needed age categories did not correlate with the population summary data of Worksheet No. 1, extrapolations were made. Participants under 16 years of age were omitted because estimates on days per participant were not available for this age group. In line 5, an estimate of 10.6 days of participation per person was used based on National survey data for the West North Central Region of the United States (U.S. Department of the Interior and U.S. Department of Commerce 1982).

Step 3

Based on October 1981-September 1982 visitation records for Lake Ilo National Wildlife Refuge, about 77 percent of the wildlife-related noncon-sumptive recreation occurs from May through September. An estimate of 77 percent was used in line 1. Assuming 22 weeks in the peak season, peak weekly demand generated by in-migrants was estimated to be about 509 recreation days. In line 6, weekend use was assumed to equal about 80 percent of weekly use, and peak day use was therefore estimated at 40 percent of peak weekly demand.

To derive estimates for lines 1, 6, and 7, users should contact managers of recreation areas which are expected to receive significant increased non-consumptive wildlife-related visitation. Resource managers can almost always suggest estimates for these values based on past visitation information.

Step 4

One use area, Lake Ilo National Wildlife Refuge, was used in the example. A current peak day demand estimate for wildlife-related nonconsumptive recreation of 53 recreation days was based on peak monthly use data for July 1982.

In line 3, a projected peak day demand for the evaluation year (1987) was needed. This estimate assumes no project-induced population growth but a continuation of past trends. Assuming a rate of 1 percent growth per year, in 1987 visitation for wildlife-related nonconsumptive recreation would have a peak day level of 56.

Step 5

In Step 5, the projected additional peak day demand attributed to the new population is apportioned to use areas. In this example, Lake Ilo National Wildlife Refuge is the only use area under evaluation. According to the National survey, this type of wildlife recreation visitation to public areas in the West North Central Region is distributed as follows: any public area, 68.7 percent; local or regional park or natural area, 34.9 percent; State-owned area, 40.5 percent; National Wildlife Refuge, 12.7 percent; and other Federal area, 12.6 percent. Because the Refuge is located so close to the primary settlement communities, the rate was adjusted upward from 12.7 to 40.5 percent. Therefore, 40.5 percent was used as the estimated "capture" rate for primary nonresidential wildlife-related recreation at Lake Ilo National Wildlife Refuge. The rationale was that at least as many persons would visit the Refuge for wildlife observation as would go to the state park, also located within easy access for a 1-day outing. Assuming that a little over 40 percent of the new demand for primary nonresidential nonconsumptive use of wildlife in Dunn and Mercer Counties occurs at the Refuge, by 1987 the peak day demand for this activity will have increased by 83 recreation days, for a total peak day demand of 139 recreation days.

Step 6

The user must enter an estimate of the use area's recreational capacity for the activity in question. The Lake Ilo Refuge Manager estimated that current peak day use represents 80 percent of the capacity of the refuge. Of course, the nonconsumptive wildlife-related activity is not the only type of activity occurring: fishing is popular, for example. Assuming that all visitors contribute equally to the capacity of the refuge (for example, with vehicular traffic or parking demand) then the peak day capacity for wildlife-related nonconsumptive use is about 66 visitor days.

In conclusion, without the projected in-migration and recreation demand, by 1987 Lake Ilo National Wildlife Refuge will be at capacity during peak use days for wildlife-related nonconsumptive recreation. With projected in-migration, the Refuge will be more than 100 percent above capacity.

Assuming that the current ratio of annual visits (all recreationists) to area of the Refuge (3,200 acres) allows maximum participation and still protects the resource, total peak day use capacity (139 visitor days) would correspond to 23 acres per visitor day. Applying this standard to the peak

213

day demand for wildlife-related recreation generated by the in-migrating population (83 visitor days) would suggest a needed increase in Refuge lands of 1,909 acres. Therefore, it could be argued that an increase in public recreational facilities to meet the demand of the in-migrating population should include an expansion of wildlife-related recreational opportunities, and that expansion at Lake Ilo National Wildlife Refuge to include about 2,000 additional acres would meet this demand. Without expansion, the additional population can be expected to increase use to more than 100 percent above peak day capacity.

Sample Worksheet No. 5

OTHER WILDLIFE-RELATED NONCONSUMPTIVE
RECREATION IMPACT ASSESSMENT

Step 1 - Developing Participation Ratios

Impact area   Dunn and Mercer Counties

Activity type   Primary, nonresidential, nonconsumptive use of wildlife

Males

1. Age group	2. Participation ratio
16-17	0.188
18-24	0.223
25-34	0.255
35-44	0.196
45-54	0.157
55-64	0.132
65+	0.071

Females

16-17	0.131
18-24	0.195
25-34	0.235
35-44	0.172
45-54	0.140
55-64	0.099
65+	0.063

Data source(s): National Survey, West North
Central Region (U.S. Depart-
ment of the Interior and
U.S. Department of Commerce
1982).

215

<u>Step 2</u> – Applying Participation Ratios to Estimate New Demand

Impact area   <u>Dunn and Mercer Counties</u>   Year <u>1987</u>

Activity type <u>Primary, nonresidential nonconsumptive use of wildlife</u>

Males

1. Age group (Step 1, Line 1)	2. No. of in-migrants (Worksheet 1, Step 4)	3. Participation ratio (Step 1, Line 2)	4. Potential new participants
16-17	110	0.188	21
18-24	924	0.223	206
25-34	1,679	0.255	428
35-44	608	0.196	119
45-54	313	0.157	49
55-64	312	0.132	41
65+	0	0.071	0
	3,946		864

Females

16-17	110	0.131	14
18-24	607	0.195	118
25-34	1,124	0.235	264
35-44	394	0.172	68
45-54	188	0.140	26
55-64	187	0.099	19
65+	0	0.063	0
	2,610		509

Source(s): National Survey, West North Central Region (U.S. Department of the Interior and U.S. Department of Commerce 1982).

TOTAL Potential New participants	1,373
5. Annual days per participant	10.6
6. Total potential added demand (days)	14,554

216

Step 3 - Converting Additional Annual Demand to Peak Day Demand

Impact area Dunn and Mercer Counties   Year 1987

Activity   Primary nonresidential nonconsumptive use of wildlife

Peak months for the activity May through September

1. Percent annual activity oc- curring in peak months		2. Total annual activity days (Step 2, Line 6)	3. Activity days in peak season		4. No. of weeks in peak season		5. Estimated peak weekly demand
0. 77	x	14,554	= 11,207	÷	22	=	509

6. Estimated percent weekend use: 0.80

                                             ÷ 2

7. Estimated percent peak day use =   0.40

8. Estimated peak weekly demand (Line 5)		9. Estimated percent peak day use (Line 7)		10. Estimated peak day demand
509	x	0.40	=	204

Step 4 - Identifying Potential Use Areas

County impact area Dunn and Mercer Counties   Year 1987

Activity type   Primary nonresidential nonconsumptive use of wildlife

1. Use area (current or planned): Lake Ilo National Wildlife Refuge

2. Peak day demand estimate[a]: 53

3. Projected peak day demand estimate[b]: 56

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[a]Only demand for wildlife-related nonconsumptive recreation is included;
   the Refuge has a total peak day demand of about 139 visitors.
[b]Again, only demand for wildlife-related nonconsumptive recreation is en-
   tered. The 1987 projected peak day demand without the project assumes
   a modest growth rate of 1% per year.

Step 5 - Distributing Peak Additional Demand to Use Areas

County impact area Dunn and Mercer Counties   Year 1987

Activity type   Primary nonresidential nonconsumptive use of wildlife

Use area: Lake Ilo National Wildlife Refuge

1. Estimated additional peak day demand (Step 3, Line 10): 204

2. Estimated percent of impact area usage: 40.5

3. Estimated additional peak day demand at area (Line 1 x Line 2): 83

4. Projected nonproject peak day demand (Step 4, Line 3): 56

5. Projected total peak day demand (Line 3+4): 139

Source(s): Refuge Manager

Step 6 - Comparing Peak Day Capacity to Demand in Use Areas

Area	1. Peak day capacity		2. Projected peak day demand (Step 5, Line 5)		3. Surplus or deficit
Lake Ilo	66	-	139	=	-73

POACHING IMPACT ASSESSMENT

Step 1

The qualitative assessment indicated that a poaching problem could be expected.

Step 2

From Worksheets Nos. 3 and 4 approximately 7,000 new annual license sales were predicted for Dunn and Mercer Counties in evaluation year 1987, following in-migration attributed to the proposed project. During 1982, Dunn and Mercer Counties had approximately 42 total arrests (Hendrickson, pers. comm.) and approximately 10,700 hunting and fishing license sales. The regression generated from Midwestern data (Equation 5) provides a point estimate of 140 additional arrests (ranging from -158 to 438). Because negative arrests are impossible, the actual number of additional arrests can be predicted to lie between 0 and 438 (line 11).

Local historical data from Dunn and Mercer Counties indicated that the previous arrest rate was 42 per 10,700 licenses. At constant conditions (poaching opportunities, sportsmen attitudes, and enforcement effort) an additional 28 arrests would be expected following the projected 7,042-license increase (line 12). However, the slope of the regression equation for the Midwestern States was 0.0054, indicating an average of 54 additional arrests per 10,000 license increase. Since the qualitative assessment used in Step 1 indicates a probable increase in poaching following in-migration, the arrest rate could be expected to increase at least to the regional average. At the regional level of 54 arrests per 10,000 licenses, a 7,042 increase in license would indicate 38 expected additional arrests (line 13). Thus, the predicted range for arrests for Dunn County based on both local and regional data would be between 28 and 38 additional arrests for the evaluation year. These values are within the range predicted by the previous regression but have been refined by using localized data. Since the qualitative assessment in Step 1 indicated that a poaching problem is expected, the upper limit of 38 additional arrests was chosen (line 14).

Step 3

Using an arrest rate per violation of 0.0233 would indicate 1,631 additional wildlife violations following in-migration, of which 38 would result in arrests.

Step 4

Assuming that those violations would be distributed as reported by Morse (1972, 1976, 1980), a total of 506 hunting, 881 fishing, 33 nongame, and 212 other violations would be expected in Dunn and Mercer Counties following in-migration for the evaluation year 1987. During 1982, 15 of 26 hunting violations (58 percent) reported for Dunn and Mercer Counties were

related to deer hunting. Assuming 58 percent of the predicted hunting vio-
lations were related to deer hunting, an estimated 293 actual deer hunting
violations are expected in 1987 with the in-migrating population. This num-
ber is shown in Step 4.

Step 5

Data for the impact area indicated that 73 percent of the deer hunting
violations resulted in an illegal harvest. This means a loss of 214 deer
is predicted with increased poaching associated with the in-migration to
Dunn and Mercer Counties.

Sample Worksheet No. 6

POACHING IMPACT ASSESSMENT

Step 1 - Evaluating the Poaching Potential.

This is a qualitative process based on yes/no questions. A preponderance
of yes answers would indicate a high risk situation for wildlife viola-
tions.

A. Are poaching opportunities a characteristic of the impact area?

1. Is there a diversity and abundance of game within
    or near the impact area?   Yes √ No___

2. Is there an extensive road system or are game other-
    wise largely accessible?   Yes √ No___

3. Are proposed project activities rural?   Yes √ No___

4. Do work shift changes place workers in or near
    wildlife habitat late at night or during peak
    periods of wildlife activity?   Yes √ No___

5. Are in-migrants expected to have free time at
    night or on weekends?   Yes √ No___

6. Do rural workers commonly carry firearms or
    other sporting equipment?   Yes √ No___

7. Could in-migrants encounter difficulties in under-
    standing the local game regulations?   Yes___ No √

8. Are residency requirements long relative to the
    anticipated tenure of in-migrants?   Yes___ No √

9. Are rural areas sparsely settled?   Yes √ No___

10. Do residents view poaching as an unimportant
    victimless crime?   Yes___ No √

11. Is there currently a poaching problem that might
    promote a similar attitude amongst in-migrants?   Yes √ No___

12. Are there monetarily important species within or
    near the impact area?   Yes √ No___

                                                    Total Yes 9

                                                    Total No 3

221

<u>Step 1</u> (concluded)

B. Do in-migrant profiles match known violator profiles?

1. Do young adults (primarily 20 to 39 year olds) comprise a large segment of the anticipated in-migration (from Worksheet 1)   Yes_√_ No___

2. Are males expected to predominate in the expected in-migration? (from Worksheet 1)   Yes_√_ No___

3. Are many of the expected children likely to be males in the mobile (i.e., legal driving age) teenage groups? (from Worksheet 1)   Yes_√_ No___

4. Are large numbers, relative to current levels, of outdoor recreationists expected? (from Worksheet 3)   Yes_√_ No___

5. Are rural workers expected to carpool, work in teams, or otherwise form groups?   Yes_√_ No___

6. Are alcoholic beverages readily available within the impact area?   Yes_√_ No___

7. Do many of the anticipated occupations have low education requirements?   Yes___ No_√_

8. Are a large number of the in-migrants expected to rent their homes? (Worksheet 2)   Yes_√_ No___

9. Are many in-migrants expected to hold more than one job?   Yes___ No_√_

10. Are in-migrants likely to live close to game areas? (Gravity Model, Worksheet 1)   Yes_√_ No___

11. Are many of the in-migrants expected to be transients?   Yes_√_ No___

Total Yes_9_

Total No_2_

Personal Evaluation   <u>Significant increased potential for poaching</u>

Step 2 - Predicting the Total Number of Arrests

County/impact area Dunn and Mercer Counties   Year 1987

1. Estimated number of licenses for hunters and anglers (Work-sheet 3, Step 4, and Worksheet 4, Step 4)		2. The slope from the appropriate regression equation		3. The Y intercept from the appropriate regression equation		4. Point estimate of the regression
4,609(hunting) + 2,433 (fishing) = 7,042 licenses	X	0.0054	+	102	=	140

5. Point estimate		6. 1 standard error		7. Predicted maximum number of arrests following in-migration
140	+	298	=	438

8. Point estimate		9. 1 standard error		10. Predicted minimum number of arrests following in-migration
140	-	298	=	-158

11. Range : 0-438
12. Point estimate (based on local historical data): 28
13. Point estimate (Equation 3): 38
14. Point estimate chosen: 38

Step 3 - Predicting the Total Number of Additional Violations.

1. Predicted number of arrests		2. Arrest rate Std. value	Your value		3. Predicted violations
38	÷	0.0233	0.0233	=	1,631

223

Step 4 - Distributing Violations by Type.

Activity	Percent of all violations		Predicted number of violations		Number of activity specific violations
Hunting	0.31	x	1,631	=	506
Deer hunting	0.58	x	506	=	293
Small game		x		=	
Fishing	0.54	x	1,631	=	881
Nongame	0.02	x	1,631	=	33
Other	0.13	x	1,631	=	212

Step 5 - Estimating Wildlife Losses Due to Poaching.

Activity/Species	Predicted number of violations		Mean kill per violation		Predicted losses
Deer hunting	293	x	0.73	=	214
		x		=	
		x		=	
		x		=	

DEER-VEHICLE ACCIDENT ASSESSMENT

Step 1

A road kill problem area in Dunn County was identified by a district warden of the North Dakota State Game and Fish Department. White-tailed deer were the species of concern. The site is 1 mile west of Dunn Center on State Highway 200. This site was also expected to receive significant project-related commuter traffic from future workers living in Killdeer. The 1982 traffic volume at the site was estimated to be 875 ADT by the North Dakota State Highway Department, Division of Planning. The 1982 reported road kill was 5 deer.

Step 2

The State district warden estimated that the site had about the same number of actual as reported road kills of deer. Therefore, reported kills were assumed to be a high percent (80 percent) of total road kills. Estimated annual total kill at the site was 6 deer.

Step 3

The district warden estimated that 8-10 deer cross the highway daily at the site during about 6 months of the year. An estimate of deer count at the site was not available. Using Figure 9 of Section 6, a ratio of 230 crossings/kill was estimated for an ADT of 875. The daily kill projected was 0.03 to 0.04 deer. Assuming a season of 183 days (6 months), the projected annual kill using this method was 5 to 7 deer. Figure 9 indicates that projected annual kill is highly consistent with actual total kills as estimated by the local district game warden.

Step 4

The projection method used was the crossings per kill method.

Steps 5 and 6

Assuming the original time schedule of the Dunn County methanol plant, the 1987 projected ADT at this site is 3,000. As current traffic volumes in this area are staying constant or even falling, all of the projected increase was attributed to the project. Annual deer crossings were expected to remain the same. Figure 9 suggested 120 crossings/kill at this ADT. Since this was the only site identified, a 1987 impact of 12-15 deer (or an increase over baseline of 7-8 deer) was projected to be attributable to project-related traffic.

Sample Worksheet No. 7

DEER-VEHICLE ACCIDENT ASSESSMENT

Step 1 - Identify Problem Road Segments

County _____Dunn_____
Species__white-tailed deer__

Current road kill problem areas:

Location/Highway	Annual reported mortality	Average daily traffic
1 mi w. Dunn Center, N.D. Highway 200	5	875

Step 2 - Estimating Current Annual Road Kills - Method 1

1. Reported annual mortality		2. Percent of total kills actually reported		3. Estimated annual kill
		Range	Value	
5	÷	(.10-.15)	.80	= 6

Step 3 - Estimating Current Total Annual Kills - Method 2

1. Average daily traffic: __875__
2. Ratio of crossings per kill at this ADT (from Figure 9): __230__

3. Estimated average daily animal crossings		4. Ratio of crossing per kill (line 2)	5. Projected daily kill		
8-10	÷	230	= 0.03-0.04		
			x __183__	6.	Days of season
			= __5-7__	7.	Projected annual kill, ADT/crossings method

8. Estimated average daily animal count		9. Ratio of count per kill (Figure 10)	10. Projected daily kill		
NA	÷	NA	=		
			x _____	11.	Days of season
			= _____	12.	Projected annual kill, ADT/count method

226

Step 4 - Selecting a Projection Method

Method	Annual kills	Variation from reported kills (line 1 ÷ line 2 or 3)
1. Estimated kills (Step 2, Line 3) =	6	
2. Crossings per kill method (Step 3, Line 7) =	5-7	negligible
3. Count per kill method (Step 3, Line 12) =	-	-

Step 5 - Projecting Future Kills

5a - ADT/animal crossings method

Road Segment: __1 mi w. Dunn Center__   Year: __1987__
1. Projected ADT: __3,000__

2. Projected annual animal crossings		3. Estimated animal crossings per kill (from Fig. 9)		4. Projected future annual kills	5. Variation factor (optional)
__1464-1830__	÷	__120__	=	__12-15__	x __neg.__

=   __12-15__
Projected future
annual kills

5b - ADT/animal count method - not used

Step 6 - Summarizing Potential Impacts

Road segment	Estimated annual road kill
1 mi. west of Dunn Center	12-15 deer

DOG PREDATION IMPACT ASSESSMENT

Previous sample worksheets used the Dunn County, North Dakota, proposed methanol plant. The example for this worksheet is hypothetical, since predation by free-ranging dogs was not considered a significant human demographic impact on wildlife in the Dunn County area, and since important winter range areas do not coincide with development near either Dunn Center or Killdeer.

Sample Worksheet No. 8

DOG PREDATION IMPACT ASSESSMENT

Community Anvil Points
Species mule deer   Year 1987
Step 1 - Estimating the Number of Dogs Entering the Growth Area

Population allocation for community = 2660 ÷ 5 = 532 estimated additional dogs
(See Worksheet 1, Step 5b)

Step 2 - Estimating the Number of Uncontrolled Dogs

Estimated number of dogs (Step 1)		Estimated number of uncontrolled dogs
532	x 0.67 =	356

Step 3 - Estimating the Zone of Influence of Uncontrolled Dogs and the Average
Density of Big Game in that Zone During Critical Winter Months

1.   Primary zone of influence of uncontrolled dogs: 113   square miles

2.   Estimate the density of uncontrolled dogs in the primary zone of influence:

Number of uncontrolled dogs (Step 2)		Square miles in zone of influence		Uncontrolled dogs per square mile in primary zone
356	÷	113	=	3.2

3.   Overlap of big game winter range with the primary zone of influence:
      14   square miles

4.   Estimate the average density of big game on the winter range in the con-
      flict zone: 60   (deer) per square mile

Step 4 - Estimating Average Winter Mortality of Big Game as a Function of Dog
Densities and Wildlife Densities in the Conflict Zone

Winter losses of deer per square mile of winter range are suggested below:

Number of uncontrolled dogs per square mile (Step 3, line 2)	Number of big game wintering per square mile (Step 3, line 4)		
	< 10	10-50	> 50
0 - 0.1	0.03	0.04	0.05
0.1 - 0.4	0.06	0.07	0.08
0.5 and above	0.09	0.15	0.30

Average Winter Loss per Square Mile (above)	x	Square Miles in Conflict Zone (Step 3, line 3)	=	Estimated Average Winter Loss
0.3		14		4-5 mule deer

229

COMMUNITY DEVELOPMENT AND WATER USE ASSESSMENT

This example assumes that increased use of water for agricultural production in Dunn and Mercer Counties is not expected to result from growth in the area; therefore, water quality and quantity changes associated with increased irrigation are not expected to be a problem. Also, grazing pressure on riparian areas is not expected to increase, so effects of overgrazing such as increased runoff and stream channel downcutting are not addressed.

Water supply for Dunn Center is already a problem and the community is considering additional wells. The source of additional water supply would continue to be groundwater and no impact on aquatic ecosystems would be forecast. A water storage facility is needed but such a structure would not be expected to require more than 1 acre of land (Jackson, pers. comm.).

Wastewater treatment for Dunn Center was also used in the worksheet example. The community's sewage treatment lagoon is in the process of being enlarged and will have a planned capacity to serve 400 persons. However, the theoretical capacity of the lagoon is actually for over twice that population, since groundwater seepage into the underground collector pipes increases the flow into the lagoon significantly. This same dilution factor allows the effluent to easily meet treatment standards, however. It was estimated that the lagoon could handle sewage from 600-700 persons without need for enlargement and still meet effluent standards, so no adverse impacts on Spring Creek were projected.

Sample Worksheet No. 9

WATER USE IMPACT ASSESSMENT

Step 1 - Determining Need for Water Supply Augmentation

Community: Dunn Center   Year: 1987

1.   Baseline population (Worksheet 1, Step 5d) = __182__ persons

2.   In-migrating population (Worksheet 1, Step 5d) = __459__ persons

3.   Total community population (lines 1 + 2) = __641__ persons (Worksheet 1, Step 5d)

4.   Planned capacity of water system in the evaluation year = __12,000__ gpd

5.   Baseline population need: $\dfrac{182}{\text{(line 1)}}$ x $\dfrac{\text{(range)}}{\substack{150\text{-}\\180 \text{ gpd}}}$ $\dfrac{\text{value}}{150}$ = __27,300__ gpd

6.   Total population need: $\dfrac{641}{\text{(line 3)}}$ x $\dfrac{\text{(range)}}{150\text{-}180 \text{ gpd}}$ $\dfrac{\text{value}}{150}$ = __96,150__ gpd

7.   Compare planned capacity (line 4) to baseline population need (line 5): excess/deficit capacity without project-induced in-migration
    = (±) __-15,300__ gpd

8.   Compare planned capacity (line 4) to total population need (line 6): excess/deficit capacity with in-migration
    = (±) __-84,150__ gpd

    If the baseline situation projects a deficit then the deficit with the in-migrating population can be assumed to be significantly greater and the assessment continues to Step 2. If deficits are to occur only with the in-migrating population, the assessment continues to Step 2. If there is no projected deficit in water supply with the projected in-migration, the assessment can conclude that human demographic impacts on water supply will be negligible.

<u>Step 2</u> - Identifying Potential Impacts Where Water Supply Augmentation Is
Attributable To In-migrating Population

Community: <u>Dunn Center</u>   Year: <u>1987</u>

1.   Identify probable source, location, size, and timing of additional water
supply. Factors that indicate surface vs. ground water use are site-specific.

        Source(s):   <u>well/groundwater</u>
        Location: <u>vicinity of existing wells</u>
        Additional capacity: <u>as needed</u>
        Year available: <u>as needed</u>
        Reservoir required?   <u>yes</u>

2.   Identify any potential adverse impacts to habitat values from increased
use of identified source(s):

     <u>Terrestrial</u>   <u>Notes</u>

     None

     <u>Aquatic</u>   <u>Notes</u>

     None

3.   Consider quantification of impacts where additional reservoir develop-
ment is proposed; include habitat loss as a land use change in Sec-
tion 3.0, Land Use Impact Assessment.

<u>Maximum: 1 acre loss</u>

<u>Step 3</u> - Determining Need for Wastewater Treatment Augmentation

1.   Baseline population (Worksheet 1, Step 5d) = <u>182</u> persons

2.   In-migrating population (Worksheet 1, Step 5d) = <u>459</u> persons

3.   Total community population (lines 1 + 2) = <u>641</u> persons (Worksheet 1,
Step 5d)

4.   Planned capacity of treatment system in the evaluation year = <u>400</u> persons

5.-8. See text

232

<u>Step 4</u> - Identifying Potential Impacts Where Wastewater Treatment Augmentation
Is Attributable To In-migrating Population

Community: _____ Dunn Center _____   Year: _1987_

1.   Identify probable type of wastewater treatment augmentation (septic tanks,
     secondary lagoon, or sewage treatment plant): _____ lagoon _____

2.   Identify potential adverse impacts to habitat values if augmentation
     does not occur:

     <u>Terrestrial</u>   <u>Notes</u>

     None

     <u>Aquatic</u>   <u>Notes</u>

     None

3.   Where a secondary lagoon has been identified as the development option,
     consider including land use impacts (habitat loss from lagoon construc-
     tion) in Worksheet No. 2, Land Use Impact Assessment. For determining
     lagoon sizes, about 10 acres/1,000 people is considered average.

ECONOMIC VALUE ASSESSMENT

Step 1

Assuming that habitat loss due to behavioral avoidance were important only insofar as it affects white-tailed deer in the vicinity of Dunn Center and Lake Ilo National Wildlife Refuge, the entry in Step 1 of the worksheet would be reasonable.

Step 2

In this example, estimated poaching impacts are high; i.e., 214 deer illegally killed in Dunn and Mercer Counties due to increased poaching. Small game and waterfowl losses were not estimated.

Additional road kill losses (over baseline losses) were estimated at 7 deer.

Dog predation was not expected to be a significant source of loss.

Step 3

The number of average days per participant in hunting deer (with fire-arms) in Dunn and Mercer Counties was estimated at 3.7. Total use-days lost to recreationists (big game hunters) were estimated at 833.

Step 4

Using the sample use-day value per deer hunting use-day ($52.62) the value foregone was estimated to be $43,832.

Step 5

Step 5 in this worksheet refers to loss of natural areas previously used for nonconsumptive wildlife-related recreation. No such losses were projected for Dunn County, although a decline in the quality of primary, nonresidential nonconsumptive recreation at Lake Ilo National Wildlife Refuge is possible due to increased crowding.

Step 6

Value foregone in this example is estimated at approximately $43,600. Essentially, this loss was attributed to the expected loss in big game from illegal harvests. If energy impacts funds were requested to help mitigate human demographic impacts on wildlife resources attributable to the Dunn County methanol plant, advantageous uses of these funds might include education programs directed toward new employees which stressed the significance of poaching impacts, and expansion of Lake Ilo National Wildlife Refuge to accommodate additional demand for nonconsumptive wildlife-related recreation.

Sample Worksheet No. 10

ECONOMIC VALUE ASSESSMENT

Step 1 - Summarizing Wildlife Losses from Land Use Conversions

County/impact area Dunn County

Year 1987

	Central site	Sphere of influence area	Utility	Road or rail	Reservoir	Other	Total
Big game							
Deer	4						4
Elk							
Antelope							
Bighorn sheep							
Other:_____							
Upland game/small game							
Pheasant							
Turkey							
Mourning dove							
Other upland birds:							
_____							
_____							
Total							
Small game mammals							
Waterfowl							
Predators							
Fish							
Bass							
Trout and coho							
Pike and walleye							
Catfish							
Panfish: warmwater							
coldwater							
Freshwater, general							

235

Step 2 - Summarizing Wildlife Losses from Other Impacts

	Use area (Worksheet No. 5)		Poaching (Worksheet No. 6)	Road kill (Worksheet No. 7)	Predation (Worksheet No. 8)	Other:	Total
	ORV	Snowmobile					
Big game							
Deer			214	7			221
Elk							
Pronghorn							
Bighorn sheep							
Other:							
Upland game/small game							
Pheasant							
Turkey							
Mourning dove							
Other upland birds:							
Total							
Small game mammals							
Waterfowl							
Predators							
Fish							
Bass							
Trout and coho							
Pike and walleye							
Catfish							
Panfish: warmwater							
coldwater							
Freshwater, general							

236

Step 3 - Summarizing All Losses and Estimating Hunting and Fishing Use-days Foregone

	1. Subtotals Step 1	Step 2	2. Total	3. Average use-days per kill or catch	4. Use-days foregone (Line 2 x Line 3)
Big game					
Deer	4	221	225	3.7	833
Elk					
Antelope					
Bighorn sheep					
Other: _____					
Upland game/small game					
Pheasant					
Turkey					
Mourning dove					
Other upland birds:					
_____					
_____					
Total					
Small game mammals					
Waterfowl					
Predators					
Fish					
Bass					
Trout and coho					
Pike and walleye					
Catfish					
Panfish: warmwater					
coldwater					
Freshwater, general					

237

Step 4 - Estimating Values of Hunting and Fishing Use-days Foregone

	1. Hunting and fishing use-days foregone (Step 3, Line 4)	2. Value per use-day (sample value)[a]	Value[b]	3. Value foregone (Line 1 x Line 2)
Big game				
Deer	833	$52.62		$43,832
Elk		43.59		
Antelope		19.70		
Bighorn sheep		12.77		
Other: _____				
Big game general		76.95		
Upland game/small game				
Pheasant		65.07		
Turkey		35.86		
Mourning dove		41.24		
Other: _____				
Total		43.03		
Small game mammals		20.48		
Small game, general		39.60		
Waterfowl				
Ducks		55.05		
Geese		7.03		
Waterfowl, general		40.29		
Predators		24.98		
Fish				
Bass		34.07		
Trout and coho		16.69		
Pike and walleye		53.60		
Catfish		22.72		
Panfish:				
warmwater		54.05		
coldwater		29.37		
Freshwater, general		19.75		
		4. Subtotal		$43,622

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[a] See Appendix L for modification of sample use-day values.
[b] Enter own value but give rationale on the worksheet.

<u>Step 5</u> - Estimating Value of Other Wildlife-Associated Recreation
Use-days Foregone

1. Use areas	2. Use-days foregone	3. Value per use-day (Sample value)[a]	(Value)	4. Value foregone (Line 2 x Line 3)
0		$14.87		
			5. Total	0

---
[a] See Appendix L.

<u>Step 6</u> - Summarizing Value Foregone

Subtotal (Step 4, Line 4) _____ $43,832 _____

Subtotal (Step 5, Line 4) _____

Total _____ $43,832 _____

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APPENDIX A. GUIDELINES FOR PLANNING SYSTEM ENTRY POINTS FOR FISH AND WILDLIFE CONCERNS

THE SEQUENCE OF EVENTS

The most important human demographic impacts on wildlife from energy development result from the human activities that accompany population growth, the physical structures that these populations require, and the associated land and water use changes. Understanding the sequence of events that may occur with development is critical to effective wildlife mitigation and enhancement plans. Table A-1 suggests some of the planning system entry points for resource managers.

The land use planning process, basically the same for counties and municipalities, begins when local government officials decide that existing plans need to be updated. A local or regional planning office or a consulting firm will usually take the lead in the technical work. Contractors should be advised of fish and wildlife concerns before they begin planning efforts.

It often takes several months to prepare new land use plans and regulations. During this time, many people may be consulted, including planners, engineers, representatives of various local and State government agencies, representatives of special districts, local private and public landowners (including the U.S. Bureau of Land Management and the U.S. Forest Service), special interest groups, and concerned citizens. However, wildlife professionals will be consulted only if the need for their expertise is recognized. Resource managers should take the lead in making their land use recommendations available to planners.

Local meetings are normally held during the planning process. Eventually, there will be official public hearings, first before the planning and zoning commission and then before the county commissioners or the city council, and, finally, approval or rejection of the plan. Participation in both informal discussions and public hearings is advisable to ensure that fish and wildlife concerns are part of the plan. However, entry into the process at the public hearing stage may be too late. Resource managers must be careful to avoid appearing in the role of nongrowth advocate, or of criticizing proposals without offering feasible alternatives; their role is to encourage the objective consideration of fish and wildlife concerns.

All major land use decisions involve trade-offs among many different values and economic concerns. Trade-offs are implicit in county and municipal land use plans, site-specific decisions, engineering design and construction, establishing linear routes, and establishing recreation activity areas or prohibitions.

Table A-1. Planning system entry points for fish and wildlife concerns.

Event	Entry point
The most critical phase is the early resource allocation phase. Coal leasing, water right permitting, and similar activities are required of a corporation seeking to develop a resource area. This represents the first point of commitment for the industry.	Resource managers can work with planners and local conservation groups to define local priorities, identify critical human demographic impacts, and mobilize public support, based on preliminary impact projections.
The company proceeds with engineering design and starts negotiating with utility companies for electric power, phone service, construction of railroad spurs, and other services for the project. The utility companies start planning and designing expansion of their facilities to serve the project and anticipated community growth. At this time, the routing for linear facilities and the location of substations and small site facilities are planned. An environmental impact statement is seldom required for incremental public utility expansion.	Resource managers need to maintain meaningful communication with utility companies and to assist in planning linear corridor routings to avoid critical or high value wildlife use areas. Permits can be made contingent on avoidance of these use areas. Problem areas should be identified and avoided, if possible.
If it appears that the permits will be given and the project will proceed, land speculation by developers may occur. In some regions, water rights can be bought and sold; the energy company may buy some, while towns and private developers may buy others. Agricultural lands may be abandoned if purchased for speculation. This is a critically important time for local governments to prepare master plans to avoid leapfrog development and to protect quality of life for rural residents.	Resource managers and planning professionals should take a multidisciplinary approach to county land use planning and zoning regulation. Land use impact projections should be correlated with habitat evaluations. The resource manager should identify the most direct and influential route to resolving conflicts. For example, raptor nest issues should be directed to the U.S. Fish and Wildlife Service Ecological Services Office for guidance.

255

Table A-1 (Continued)

Event	Entry point
The company publicly announces that it is considering an energy development project. Projections of environmental, social, and economic impact will be made in the EIS. Local land use authorities will continue preparing land use plans and regulations. Municipalities may start preliminary engineering design for water and sewer facilities and other public works.	Human demographic impacts, mitigation, and enhancement measures should be included in the EIS. Resource managers should make land use recommendations to municipalities wherever satellite facilities are under consideration.
The company announces a starting date for the project:	As applications for energy impact assistance take form, resource managers can make the case that human demographic impacts on wildlife are a valid cost to society and that existing residents should not have to bear the burden of reduced quality of life. Energy impact offices and energy companies
a. Local governments update their land use plans and revise their regulations. They also start efforts to get funding for public works projects and services.	will begin to consider requests for assistance in addressing these impacts, especially if resource managers coordinate their applications for compensation or mitigation with community and county plans. Company commitment to employee education programs will be particularly important
b. Population projections are prepared by the energy company; the impacted counties, municipalities, and school districts; two or three State agencies; the telephone company; the electric power company; and perhaps the regional council of governments. These projections may be different because they are intended for different purposes. Some municipalities, counties, and school districts use their projections to get Federal and State funding; it is to their advantage to show as high a level of population growth as can reasonably be predicted. Some State agencies have the responsibility of assisting local governments in getting Federal funding, but also in distributing some State and Federal funds to communities in the State. These agencies tend to emphasize midlevel projections. The company may tend to emphasize lower range projections.	and resource managers can prepare and present such programs.

256

Table A-1 (Continued)

Event	Entry point
The company starts construction of any temporary or permanent housing it has agreed to build.	Land use regulations, particularly those applying to rural county lands, are critical for the success of impact mitigation. If unregulated, critical use areas may often be prime sites for satellite or recreational development.
Job-seekers begin to arrive in the region. They will occupy available rental housing, and some will use campers or tents. Their camping locations will generally be within the sphere of influence of the larger towns, near the mine site, at camping grounds in parks, or on private rural land where landowners will allow them to connect to their utilities. The impacts to wildlife may include pollution from camping wastes, predation by dogs, and harassment.	Enforcing state health regulations can be useful in controlling ad hoc camping sites.
Construction workers and more job-seekers arrive. More temporary housing may appear. There is pressure on municipal and county governments to quickly meet the needs of construction workers and other job-seekers. County commissioners, city councils, planning and zoning commissioners, technical staff, and review boards may find themselves involved in so many proposals that design and engineering plans may be approved without significant review if local governments lack adequate technical staff. If county governments do not have enough inspectors, actual construction may be different from what was approved. Zoning violations may frequently occur during the first several years of a boom.	Education of newcomers about wildlife values will be an important part of the energy industry's training program, and resource managers should make such programs readily available.

257

Table A-1 (Continued)

Event	Entry point
Construction of trailer courts and new homes starts. Trailer courts and subdivisions may begin to appear in rural areas, as well as in towns. The location and density of rural housing will depend to a great extent on whether or not the county has adopted land development regulations. If there are no regulations, housing may be scattered.	Resource managers and conservation groups can lend assistance to planning professionals in advocating annexation rather than isolated communities.
Municipalities may find their sewage systems overloaded. Engineering design is completed for new systems and expansion of old ones. The location of new main lines for water and sewage will determine the future direction of growth for the towns.	Resource managers and planners, working together, can plan for growth into areas advantageous to communities while avoiding high value wildlife areas.
From the start of the influx, the new population will explore the surrounding countryside for recreation opportunities. Over time, certain public lands may become heavy use sites; for example, access to rivers for rafting and tubing, an area for off-road vehicle riding and racing, sites near lakes or rivers for camping, and snowmobiling areas. There may be no particular planning for such designations. If some of these areas happen to conflict with fragile or critical use areas for wildlife, their loss may be irreversible. It is difficult to reverse strong user trends once they have started.	The key is prevention; to identify potential development-wildlife conflicts well in advance and take steps to protect wildlife values. This may involve zoning changes, fencing, posting, education, law enforcement, planning of alternate areas to attract people, or a combination of all of these actions.
The construction phase of the project continues for several years. Even when the housing situation for the temporary construction worker population becomes resolved, there may be a large number of workers in temporary housing in rural areas every season.	During peak employment years, education of the in-migrating population is very important.

258

Table A-1 (Concluded).

Event	Entry point
When the construction of the project nears completion and operations workers begin to arrive, the population peak may have passed. Business and commerce continues to develop. Strip development along highways may emerge. Highway and road construction may increase. Water and sewer systems are improved. Communities may consider new recreation areas, airport expansion, and other amenities.	The political philosophy in a sparsely populated region will change, and the change can ultimately affect laws that govern fish and wildlife values. People living on or close to the land often have a "land ethic." A legislative district can change very quickly to reflect a more development-oriented philosophy regarding natural resources. The resource manager and planning professional should promote quality of life considerations, especially where land use decisions are concerned.
Expansion of communities that are surrounded or bordered by winter range can have a detrimental effect on big game if growth into foothills or canyons reduces the lower fringes of critical ranges for survival in severe winters. Similarly, small farms, ranches, or a new lumber mill may occupy land where deer or elk formerly wintered. Recreational use of land, both publicly and privately developed, becomes an increasingly higher economic use of the more accessible lands. Resorts, dude ranches, summer and winter homes, or campgrounds may encroach on winter range. Finally, water development projects may be constructed in valleys and canyon bottoms that are critical winter range.	Geographically based inventories of habitat and high value use areas are important tools here.

259

Major issues about which resource managers need information include:

The need to build housing, public works, service facilities, and commercial and industrial facilities. Fairly significant quantities of land may be converted to these uses. There are, however, location choices that can guide growth among different communities within a region (within the limitations of the gravity factors). There are also choices with respect to environmental mitigation strategies, both structural (e.g., fencing) and nonstructural (e.g., zoning). Finally, there are choices within a community with respect to uses allowed on certain parcels of land, stream protection measures, and requirements imposed on developers.

The capital costs of construction and continuing costs of operation and maintenance for any physical construction. These factors are very significant with respect to location and design of roads, water and sewer projects, and other major public works projects. Construction of 1 mi of paved road can cost from $250,000 to $1 million. In some instances, it may be cheaper to create new habitat for fish and wildlife than to change the planned location of a road or other major structure.

Protection of the recreation and tourism sector of the economy. In many mineral development regions, tourism and recreation are significant to the economy. Enough backcountry land must be preserved to keep the area attractive and to support enough wildlife to ensure a satisfactory experience for recreationists. A cooperative attitude can be developed between resource professionals and the business community by stressing mutual concerns for the long term stability of the area's natural resource assets.

Protection of the agricultural sector of the economy. Preservation of watersheds, irrigation waters and channels, and grazing lands are important to this sector. Agricultural lands may be meeting important wildlife needs. Alliance with the agricultural community is an important strategy for resource professionals to consider.

Individual rights versus the common good. Historically, there has been a strong feeling in rural areas that individuals should have the right to do what they want to their own property. This can be a sensitive issue with respect to limiting or qualifying the kinds of development that may take place in rural areas. Resource professionals should be aware of these views when educating people on human demographic impacts to fish and wildlife from urbanization; the need for stewardship, both public and private, of remaining natural areas; and mitigation and enhancement options available to local decisionmakers.

The cost of administering and enforcing land use regulations and environmental protection regulations. Concerns for these costs can be countered with presentations of the monetary value of the resources to be protected.

Environmental quality, wildlife management and protection, and environmental ethics. There is a wide range of views on the level of environmental quality necessary or desirable. Personal opinion surveys show a strong belief in the importance of wildlife and a desire to conserve game and nongame species for the benefit of future generations. Resource managers can use this factual data on personal and economic values of fish and wildlife resources.

260

Site-specific issues. Most counties or regions have natural features that are part of the uniqueness of the area (e.g., fossil beds, a ghost town, a feeding ground drawing moose or elk into close proximity to town, or a particularly scenic view). Protection of such features usually has a high value in trade-off decisions. Presenting fish and wildlife needs in a manner that highlights the contribution of these resources to the area's unique natural resource heritage can be effective in raising public consciousness and support for resource conservation and enhancement.

A FINAL NOTE: CUMULATIVE IMPACTS

It should be remembered that impacts from some developments will be regional in scope. Coal and oil shale formations underlie vast land areas, usually extending through several counties and often crossing State lines. Over time, many mines and associated processing and power plants may be built in the region, and each new mine will create its own impact area. In many regions, more than one energy project may be under development at the same time. On a regional basis, different towns may alternately become growth centers. Over a 20-yr span, expansion of human settlements, construction of linear facilities, and dispersed human activities may affect nearly all of the land in a previously isolated rural region.

Furthermore, regional growth may be greater than the sum of the projections for each individual energy project. This occurs when development in the region induces population growth in larger cities that serve as business, service, and administrative centers. Such centers may not be in the mineral region, but may be close enough so that impacts from their growth (e.g., human activity patterns) affect the impact area. These spillover impacts will be added to the impacts on fish and wildlife from local population expansion. The eventual preparation of a regional cumulative impact analysis should consider all these associated influences.

Finally, because of the geographic scope of energy developments, the public decisionmaking authority to mitigate adverse impacts on fish and wildlife resources or enhance the resource base may be widely distributed, perhaps among many municipalities and counties, as well as water conservancy districts, Indian reservations, or Federal management agencies. Without communication, coordination, and defined policies for resource use and enhancement, each authority may make decisions regarding fish and wildlife within its own jurisdiction that, taken on a regional basis, could have combined impacts that will be detrimental to certain species or local populations.

APPENDIX B.   ESTIMATING THE DEMOGRAPHIC IMPACTS OF ENERGY DEVELOPMENT

INTRODUCTION

This appendix provides an overview of factors that influence the demographic effects of energy projects and describes the worksheet procedure for estimating the magnitude and distribution of population in-migration in somewhat greater detail. The factors influencing the magnitude and distribution of project-related human in-migration are complex, and a comprehensive discussion of these factors is beyond the scope of this report. Likewise, a variety of procedures can be utilized to project an energy development project's demographic impacts, but a complete review of these methods will not be undertaken here. (For a comprehensive review covering both of these topics, see Chalmers and Anderson 1977; Denver Research Institute 1979; Murdock and Leistritz 1979; and Leistritz and Murdock 1981.)

FACTORS AFFECTING SOCIOECONOMIC IMPACTS AND IMPACT ASSESSMENT

Table B-1 summarizes the causal forces and project effects that comprise the socioeconomic impacts of an energy development project. The two categories of causal factors are: (1) characteristics of resource development projects; and (2) characteristics of areas where development projects are sited. These categories include factors that are instrumental in determining the nature and extent of the economic effects of a project, which, in turn, determine population changes, the real concern in this section.

The four categories of project effects that influence population change are: (1) characteristics of project work forces; (2) local trade and service sectors and other basic industries; (3) population growth and the location and characteristics of new populations; and (4) public services and community infrastructures.

Although a realistic assessment of the economic and associated demographic changes likely to occur in impact situations requires a detailed understanding of the interrelationships among the factors outlined above, the intent here is to provide only an initial understanding of the importance of these dimensions and their many possible forms of interaction.

Causal Forces

The characteristics of the resource development project and of the site area interact to influence virtually all impact dimensions and all phases of the impact process.

262

Table B-1. Key economic and demographic impact dimensions.

Item	Key components	Relationships to other impact dimensions
Causal forces		
Project characteristics	Work force magnitude, skill level requirements Linkages to other sectors Investment Resource requirements	Strong relationship to all impact dimensions Relationships to work force characteristics and secondary economic effects are especially important
Site characteristics	Population size, composition, skill levels Economic structure Resource ownership Public service infrastructure Unemployment and underemployment	Strong relationships to all impact dimensions
Project effects		
Work force characteristics	Local hire rate Worker demographic characteristics Origins of in-migrants Worker productivity	The major determinant of characteristics of new populations Also influences secondary economic effects and public service requirements
Secondary economic effects	Indirect and induced employment and income effects Effect of linked industries Effects on local trade and service firms Effects on wage rates and unemployment	Closely related to population effects Also related to public service effects
Characteristics of new populations	Total population change Population composition Location of population growth	The major determinant of effects on public services and infrastructure Closely related to secondary economic effects
Effects on public services and community infrastructure	Housing Public utilities Quasipublic services (e.g., medical care) Effects on service structures	Related to work force characteristics

Project characteristics. Project characteristics are particularly important in influencing work force characteristics. Energy development projects differ in their work force requirements, in the timing of those requirements (particularly the relative magnitude of construction and operations work forces), and in the mix of skill levels required. Skill requirements, in turn, influence the extent to which a project utilizes local labor and the wage and salary levels of project workers. The nature of the technology, coupled with the project's construction schedule, will determine the size of the peak work force, which, in turn, is a key factor in determining the nature and magnitude of population effects.

The project's resource requirements and linkages with other economic sectors are key determinants of secondary economic effects. Development projects differ substantially in their economic linkages. The resource requirements of a given technology, such as use of water and land, are primary determinants of effects on other basic sectors, such as agriculture.

Site characteristics. Characteristics of the site have an influence that is pervasive across all impact dimensions. An area's natural resource base is a major determinant of the feasibility of locating various types of facilities there. Land and mineral ownership patterns will affect both resource development and private decisions on land use. Site characteristics also may influence the demographic effects of a new project in other ways. First, the size of the local population, the skills of current residents, and the extent of underemployment and unemployment will affect the proportion of a project's employment needs that can be met by local recruitment and, conversely, the amount of in-migration. Second, site characteristics will have a substantial influence on the settlement patterns of in-migrating workers and their families. The number of communities within commuting distance of the project site, the quality of the local transportation networks, the availability of housing and public and private services, and growth management policies in the impact area all influence worker settlement patterns and accompanying land use changes. Finally, the availability of housing and services, together with the degree of isolation of the site, will influence the proportion of the in-migrating workers who bring their families to the site area.

The secondary economic effects of a project are influenced substantially by site characteristics. The area's economic structure will affect the energy company's ability to purchase supplies and materials locally and may influence the likelihood that project workers will purchase goods and services locally. This, in turn, affects the area's growth potential as a regional center.

Project Effects

The four categories of project effects also include a number of key relationships.

264

Work force characteristics. Project work force characteristics form some of the key dimensions of population impacts. The major characteristics of interest in this analysis are the proportion of the workers who are in-migrants to the area, their age and worker profiles, and the number and demographic characteristics of their dependents.

Population change in an area of a new development project is strongly influenced by project work force characteristics. The proportion of the project work force who are in-migrants, together with the demographic characteristics of these migrants, is a major determinant of the population increase (Murdock et al. 1980a). In addition, increased employment opportunities resulting from a new project may lead to substantially reduced out-migration from the project area.

Work force characteristics also may be an important determinant of the secondary economic effects of a new project. The propensity of project workers to purchase goods and services locally, rather than in distant trade and service centers, together with the wage and salary levels of the project workers, is a major determinant of the indirect and induced employment and income effects of a new project (Tweeten and Brinkman 1976), which, in turn, influence in-migration.

Public service effects also depend in large measure on work force characteristics. Local hiring by the firm will affect the labor supply available to local public entities and to firms engaged in construction of housing and public facilities (Gilmore 1976). In addition, the demographic characteristics of in-migrating project workers will affect the type of housing they desire (Leholm et al. 1976; Wieland et al. 1977), and workers' salary levels will influence their ability to pay for different forms of housing.

Secondary economic effects. Another important category of project impacts is secondary economic impacts. Project-related purchases of supplies and materials from local firms, together with expenditures by project workers, typically result in increased business activity and employment in the local trade and service sectors. Growing indirect and induced employment in the area is likely to lead to some in-migration of secondary workers and their dependents.

Characteristics of new populations. Of special importance in this study is the magnitude of population change resulting from the project, the rate of that change, the age and sex composition of the new population, and the location of population change within the study area. Population growth associated with a new project, together with the location of that growth, is the key determinant of additional human demographic impacts on fish and wildlife resources. Substantial population growth in a rural community will result not only in land use changes, but also in increased demands on recreation resources and use of public and private land. The residential location of in-migrating populations will determine, in large measure, the location of secondary land use impacts. The composition of new populations can be expected to affect the mix of recreation needs experienced. The socioeconomic profile of the new population will affect the likelihood of increased wildlife regulation violations.

265

Effects on public services and community infrastructure. A new development project may lead to substantial changes in local public services and facilities. Important dimensions of public service changes and associated land use impacts include increased requirements for housing (and changes in type of housing); public utilities, such as sewer and water; public services, such as education and fire and police protection; and quasipublic services, such as medical care. In addition, the changes in levels and types of public service needs that accompany development often lead to changes in the organization of service delivery systems. All of these factors will influence future land use patterns in a growth area.

Public service and infrastructure effects can be expected to have significant interactions with a number of other impact dimensions. Lack of satisfactory housing and services may influence worker productivity and turnover rates (Gilmore 1976). If an area lacks the services that workers and their families desire, social problems attributable to stress and lack of community support systems may increase. Similarly, if public services are inadequate to meet basic needs and residents feel the local quality of life has been degraded, social conflict between old and new residents may arise, leading to undesirable social outlets (e.g., crime and drug abuse).

In summary, these are some of the major factors and their interrelationships that, implicitly or explicitly, must be considered prime causes where human demographic impacts on fish and wildlife are concerned.

DEMOGRAPHIC IMPACT ASSESSMENT PROCEDURES

Evaluating the potential population effects related to a new energy development project involves several distinct steps. At each step, some variation in procedures may be appropriate, given the unique characteristics of a given project and site. In addition, the time and resource limitations under which an assessment is conducted influence the procedures selected at each step. (For a detailed discussion of alternative assessment procedures, see Leistritz and Murdock 1981.)

In designing the estimation procedures for this study, four specific design criteria were utilized. First, the procedure must provide population projections with sufficient detail about age and sex characteristics to allow subsequent use of the projections in estimating impacts on fish and wildlife resources. Second, the procedure must allow the analyst to differentiate the impacts of the construction and operations phases of a project. Third, the procedures must be adaptable enough to provide impact estimates for both the total impact area (county or region) and the individual communities. Fourth, the computational procedures must be relatively simple and suitable for implementation by personnel who do not have access to computer facilities and who are not economists or social scientists.

266

The procedure that has been developed includes the following major steps:

Step 1 - Projecting direct project employment (construction and operations workers)

Step 2 - Estimating secondary employment

Step 3 - Estimating the in-migrating fraction of workers (construction, operations, and secondary)

Step 4 - Estimating the demographic profile of the new (in-migrating) population

Step 5 - Estimating the residential location of the in-migrating population

Step 6 - Estimating the housing requirements of the in-migrating population.

Projecting Direct Project Employment

The critical initial step is obtaining accurate estimates of the number of construction and operation workers the project will employ. Such estimates should ideally be obtained directly from the developer. If work force information is not available from the developer, or if the information provided is incomplete, several secondary sources provide general estimates of typical work force requirements for facilities of different types (see Stenehjem and Metzger 1976; Briscoe, Maphis, Murray, and Lamont, Inc. 1978; Murdock and Leistritz 1979). Guidance on these work force requirements is shown in Table B-2.

While the developer is clearly the best source of information concerning the work force requirements, such estimates should still be critically evaluated. Recent reviews of environmental impact statements indicate a general tendency for developers to underestimate the construction work force requirements of proposed projects (Braid 1980; Gilmore et al. 1982). These analyses indicate that construction work force requirements often have been underestimated by as much as 50%. (The estimates presented in Table B-2 reflect recent experience with respect to actual, not estimated, work force levels of typical facilities.)

Because all other impact projections tend to be based on the direct employment requirements, substantial errors in these estimates can be expected to invalidate all other components of the assessment. It is, therefore, advisable for the analyst to examine such estimates with care, to compare them with information from secondary sources and with recent experience for similar projects, and to raise questions if substantial disparities are identified.

Table B-2. Sample energy facility employment characteristics.

Type of facility	Size	Construction period (yr)	Peak construction work force (persons)	Peak operations work force (persons)
Surface coal mine	9 million tons/yr	2-3	150-200	300-500
Underground coal mine	2 million tons/yr	2-3	225-325	550-830
Electric generating plant	700 MW	4-6	750-2,700	90-170
(includes surface coal mine)	2,250 MW	6-8	2,000-5,000	350-650
Synthetic gasification plant (includes surface coal mine)	250 million ft^3/day	3-5	3,000-5,000	1,050-1,500
Oil shale processing facility (includes mining)	50,000 bbl/day	3-5	1,500-5,000	1,400-4,000
Uranium mining and milling	1,000 tons U_3O_8 concentrate/day	1-3	130-250	200-250

Source: Gilmore et al. 1982; Leistritz et al. 1982b; and Midwest Research Institute estimates.

Projects that involve a large region or an indeterminantly long time frame may especially require that information from developers be supplemented with data from secondary sources. Government and industry publications that provide compilations of development plans may be consulted, but information from these sources should be cross-checked with that available from local planning officials and industry representatives. Federal and State agencies that have responsibility for permitting or licensing new projects can be a valuable source of information concerning those projects that are scheduled for development in the near future.

Once estimates of direct project employment have been obtained, they can be entered into the impact projection worksheet. Direct project employment should be estimated for each year of the project construction period and for the first several years of the operational period.

Estimating Secondary Employment

Estimating the secondary (indirect and induced) employment that will occur as a result of project development is the second major task. While several techniques exist for estimating secondary employment, the employment multiplier approach was chosen for use in this assessment procedure. Advantages of the employment multiplier approach are that it utilizes data that are generally more readily available than those required for alternative techniques and that the computations involved are simpler than those for most other methods (Leistritz and Murdock 1981).

A fundamental requirement in using the employment multiplier approach is to determine the multiplier value(s) to be employed. The magnitude of secondary economic effects can be expected to vary among projects and sites and between the construction and operations phases of a project. Projects that result in the purchase of a large percentage of their inputs within the study area will produce larger secondary economic effects. Similarly, study areas with more diverse, self-sufficient economic structures will generally have larger multipliers.

It is in the selection of an employment multiplier that the analyst must first give serious attention to the definition of the study area and its baseline characteristics. For traditional socioeconomic impact analysis, the study area (or area of project influence) generally includes all communities or jurisdictions that can reasonably be expected to experience significant employment or population effects as a result of project development or to experience substantial project-related tax revenues (Gilmore et al. 1982). Thus, the study area usually includes all communities from which significant numbers of workers could be expected to commute on a daily basis. When the project is located in a sparsely populated area, the study area generally also includes the regional trade and service center because such cities often experience much of the secondary economic effects and serve as the place of residence for a large segment of the construction work force. Considerations of data availability usually suggest that the study area be defined along county lines.

For purposes of this procedure, the specific issues that are of greatest concern to the resource manager may influence the selection of a study area. It is assumed that potentially significant adverse impacts stemming from land use and human activity changes in rural areas will usually relate to potential land use changes in specific communities and areawide. The areawide analysis may include such things as recreation demand and potential wildlife regulation violations. For example, if a project's effects on wildlife through increased hunting pressure are being assessed, estimates of project-related population growth at the multicounty (study area) level may be as useful as community-specific estimates. Finally, analysis of very site-specific impacts, perhaps even beyond the county where the project is to be located, may be necessary (e.g., road kill projections).

Employment multiplier values that appear appropriate for study areas with various characteristics are summarized in Table B-3. These multiplier values are presented by ranges. Within a given study area type and project phase, values toward the higher end of the range should be selected if the project is expected to have an above average percentage of local expenditures or if the study area economy is quite self-sufficient, offering a wide range of goods and services. Opposite characteristics would suggest that values toward the lower end of the range would be more appropriate. Here again, the analyst should consult with other sources to confirm the characteristics of the study area and select the secondary employment multiplier.

Table B-3. Secondary employment multipler values appropriate for various types of impact areas.

Impact area characteristics	Level of analysis	Construction phase	Operations phase
Rural, sparsely populated, no large trade center within impact area	Regional[a] County	0.3-0.7 0.2-0.4	0.5-1.2 0.3-0.6
More urbanized impact area, population densities moderate	Regional[a] County	0.4-0.8 0.3-0.5	0.6-1.3 0.4-0.8
On fringe of metropolitan area	Regional[a] County	0.5-0.9 0.4-0.7	0.7-1.5 0.6-1.2

[a]Multicounty impact area (area of significant project influence).

Source: Gilmore et al. 1982; Leistritz et al. 1982a; and Midwest Research Institute estimates.

Multiplier values are generally lower for the construction phase than for the subsequent operations period. This is because a significant portion of the construction work force is often made up of long distance commuters,

270

whose expenditures within the study area are often minimal. The multiplier values also are greater at the regional level than at the county level because regional trade centers often provide a large part of the higher order goods and services for outlying counties in their trade area, and, therefore, experience a substantial portion of the secondary economic effects of a major project (Gilmore et al. 1982).

A second major consideration in applying the employment multiplier approach is estimating the timing of secondary employment effects. The approach incorporated in the recommended procedure is a "ceiling to nonbasic employment growth" (Mountain West Research, Inc. 1979). The basis for this approach is that the local trade and service sector is not likely to expand during the construction phase beyond that level of employment that can be sustained during the postconstruction period. Thus, as shown on Worksheet No. 1 (Step 2), secondary (nonbasic) employment estimates for the project construction phase should be constrained to a level not exceeding the average of secondary employment during the first 2 yr after construction activity ends.

The recommended procedure for estimating secondary employment effects is summarized in Worksheet No. 1 (Step 2).

Estimating In-migrating Work Force

The third major step in the impact analysis procedure is estimating the proportion of the direct and secondary workers that will be recruited from the local labor force and, conversely, the fraction of project-related jobs that will be filled by workers who relocate to the area. Studies of the local recruitment patterns of energy development projects in several areas in Western States indicate substantial differences in such patterns between the construction and operations phases, as seen in Table B-4. These data also indicate substantial variations in local recruitment rates among construction sites and among permanent work forces. These differences are attributable largely to variations in the number and skill levels of available local workers, union practices, the extent of competing demands for workers by other projects in the region, and (particularly for permanent work forces) the developer's policy with regard to hiring local workers versus recruiting experienced workers elsewhere or transferring such personnel from other company-operated facilities (Murdock and Leistritz 1979; Wieland et al. 1979). Examination of Table B-4 and the studies from which this table was derived reveals that local workers make up 30 to 50% of most construction work forces, with 40% being a typical value. Local workers make up 40 to 70% of most operations phase work forces, with 60% being a typical value for Western coal projects.

For purposes of the assessment procedure outlined here, it is suggested that local hiring values of 30 to 50% for construction workers and 40 to 70% for permanent employees be used unless unusual local conditions indicate that different values may be more appropriate. Interviews can be conducted with company construction managers and personnel supervisors and with union officials to verify the appropriateness of such estimates in light of local conditions and project plans. Monitoring reports from similar projects or projects in the same area may also provide useful insights. (For a review and analysis of such monitoring studies, see Leistritz and Chase 1982.)

271

Table B-4. Local workers as a percentage of the total work force for energy projects in the Western United States.

Study	Project type	Number of projects	Percent local workers[a]		Source of study
			Average	Range	
Construction:					
Construction Worker Profile	Power plant construction	14	39.9	3.3-78.6	Mountain West Research, Inc. (1975)
Electric Power Research Institute	Power plant construction	9	51.8[b]	15.0-80.0	Gilmore et al. (1982)
Operations:					
Operation Worker Profile	Coal mine and power plant operation	14	61.8	14.0-95.7	Wieland et al. (1977)
Texas Uranium Workers	Uranium mine and mill operation	4	68.9	NA	Murdock et al. (1981)
Wyoming Uranium Workers	Uranium mine and mill operation	6	51.0	48.0-56.0	Dobbs and Kiner (1974)
Campbell County (Wyoming) Coal Workers	Coal mine operation	15	35.5[c]	-	Browne et al. (1981a)
Sweetwater County (Wyoming) Coal Workers	Coal mine and power plant operation	2	60.0	-	Browne et al. (1981b)
North Dakota Oil and Gas Workers	Petroleum exploration and extraction	-	48.0	-	Chase and Leistritz (1982)
Electric Power Research	Power plant	7	49.9[b]	16.0-95.0	Gilmore et al. (1982)

a Although minor differences in definitions exist among the various studies, local workers are generally defined as employees who do not relocate in order to accept employment with the energy project.

b This study included power plant sites Nationwide.

c Definition of local workers in this study is not strictly comparable to that used in other studies cited. Workers who had moved to Campbell County within 6 months prior to employment were classified as nonlocal, as were any workers whose previous residence was outside Campbell County (even though some workers from adjacent counties may commute on a daily basis). Changing the definition of local workers might raise the figure for this study by 10 to 15% (from 35.5% to 45 to 50%).

272

Another dimension of project-related in-migration that needs to be addressed by the assessment methodology is the relocation of workers to fill secondary jobs. Unfortunately, whereas several studies have addressed the local and nonlocal composition of construction and operations work forces, no comparable data exist for the secondary work force.

Studies that have addressed the local hiring rate for secondary workers have relied exclusively on interviews with knowledgeable local observers in impact areas rather than on surveys of the workers themselves (Gilmore et al. 1982; Leistritz and Maki 1982). These studies conclude that a substantial majority of the new secondary jobs in impacted areas have been filled by either local workers or spouses of relocating construction and operations workers.

Within the recommended procedure, 50 to 70% of the secondary jobs are assumed to be filled by local workers. Values toward the lower end of the range would be most appropriate for areas experiencing very tight local labor market conditions.

The procedure also requires an assumption concerning the availability of spouses of construction and operations workers to take secondary jobs. As is the case with respect to the local and nonlocal composition of the secondary workers, little empirical information is available concerning the percentage of spouses who fill secondary jobs. In a survey of several communities near construction sites, Mountain West Research, Inc. (1975) found that only 12% of the construction workers' spouses were employed. Other surveys of energy work forces (largely operations workers) in Sweetwater and Campbell Counties, Wyoming, on the other hand, revealed that the average energy worker's household included 1.5 employed adults (Browne, Bortz, and Coddington 1981a,b). Based on these results and those of recent case studies (Gilmore et al. 1982), 20 to 40% of construction and operations workers' spouses are assumed to be available for secondary employment. Values toward the lower end of the range are believed most appropriate during construction periods and in remote locations, while values near the higher end may be more appropriate for the operations phase and for locations near major trade and service centers where a greater variety of employment opportunities are typically available.

A final factor considered in this step of the procedure is the replacement workers who fill existing local jobs vacated by locally hired construction and operations workers. In the recommended procedure, 30 to 50% of the locally hired construction and operations workers are assumed to represent jobs that will be filled by in-migrants. Values toward the higher end of the range appear more appropriate for areas experiencing very tight labor market conditions.

The procedures for estimating the number of in-migrating workers of each type are summarized in Worksheet No. 1 (Step 3).

Estimating the Demographic Profile of In-migrating Workers

The fourth major step in the impact assessment procedure is estimating the demographic profile of in-migrating workers. As in the case of local hire rates, analyses of the demographic characteristics of construction and operations workers have been conducted (see Mountain West Research, Inc. 1975; Wieland et al. 1977; Murdock and Leistritz 1979; Murdock et al. 1980b), but comparable information for secondary workers is not available.

Selected demographic profile data for construction, operations, and secondary workers are presented in Table B-5. The information for construction workers was derived from a survey of 14 Western energy project construction sites (Mountain West Research, Inc. 1975). The operations work force profile is based on analysis of survey data from 14 coal mines and power plants in the Northern Great Plains (Wieland et al. 1977). More recent studies report similar values for construction workers at water development projects in Western states (Mountain West Research, Inc. 1977) and for permanent (operations) workers at coal mines and power plants in Wyoming (Browne, Bortz, and Coddington 1981a,b). The values reported in Table B-5 appear typical for Western energy projects.

The data in Table B-5 suggest that 20 to 30% of the workers of each type will be unmarried (single, widowed, or divorced). A substantial percentage of the construction workers are assumed to be married, but with their families living elsewhere (i.e., outside the impact area). Such workers are frequently termed "weekly commuters" or "travelers." This component of the construction work force is likely to be responsive to local housing conditions, more,so if the developer provides low cost single status housing (often termed "man camps" or "bachelor quarters") and less so if housing suitable for family living is readily available. Interviews with company officials and an evaluation of the local housing situation should suggest the proportion of weekly commuters that will be most likely given local conditions. Weekly commuters are not expected to account for a significant percentage of the operations or secondary work forces (Mountain West Research, Inc. 1975; Gilmore et al. 1982).

The family sizes for married workers of each type and the age distributions for workers, spouses, and children (Table B-5) appear to be representative values applicable to most Western energy projects. Accordingly, these values are incorporated into the recommended procedure as standard values. Analysts have the opportunity to alter these values, however, if specific information concerning the project or site suggests alternative values. In general, the data in Table B-5 indicate that workers of each type tend to be clustered in the 20- to 34-yr old group (65 to 70% of each worker type falls into this age bracket). Consistent with this age structure, family sizes are relatively large (3.4 persons/family), but children tend to be concentrated in the preschool and primary grade age groups. More than 70% of children for each worker type are less than 12 years old.

274

Table B-5. Demographic characteristics of in-migrating construction, operations, and secondary work force.

Characteristics	Work force		
	Construction[a]	Operations[b]	Secondary[c]
Worker marital status:			
Unmarried or married with family absent (weekly commuter)	40-60%	20-30%	20-30%
Married, family present	40-60%	70-80%	70-80%
In-migrating children per family	1.4	1.4	1.4
Age distribution of workers (years):[d]			
20-24	24.0%	19.6%	19.6%
25-34	40.6%	52.6%	52.6%
35-44	15.9%	16.7%	16.7%
45-64	19.5%	11.1%	11.1%
Age distribution of children (years):			
Under 5	35.4%	39.2%	39.2%
5-11	36.1%	34.8%	34.8%
12-14	11.4%	13.3%	13.3%
15-17	10.8%	9.5%	9.5%
18-19	3.8%	2.5%	2.5%
20-24	2.5%	0.7%	0.7%

a Mountain West Research, Inc. (1975).

b Wieland et al. (1977).

c Secondary work force characteristics are assumed to be identical to those of the operating work force, except for sex distribution.

d Spouses of workers are assumed to have the same age distribution as that of the workers.

The procedures for utilizing the demographic profile data in conjunction with in-migrating work force estimates to project the population change associated with a new development project are summarized in Worksheet No. 1 (Steps 3 and 4). Completion of Step 4 results in estimates of the population effects of the project for the study area. The population is characterized by type (employment of household head) and an age and sex profile of each population type is provided.

275

A more detailed age distribution is generally not needed, but, in the event that impact assessment of hunting and fishing requires alternative age categories, Table B-6 can be used to compile alternative population profiles.

Table B-6. Detailed age distribution of in-migrating construction, operations, and secondary work forces and dependents.

| | Worker type (%) | | |
	Construction	Operations	Secondary
Age distribution of workers and spouses (years):			
20-24	24.0	19.6	19.6
25-34	40.6	52.6	52.6
35-44	15.9	16.7	16.7
45-54	14.6	8.3	8.3
55-64	4.9	2.8	2.8
Age distribution of children (years):			
Under 5	35.4	39.2	39.2
6-8	18.1	17.4	17.4
9-11	18.0	17.4	17.4
12-14	11.4	13.3	13.3
15	3.6	3.2	3.2
16-17	7.2	6.3	6.3
18-19	3.8	2.5	2.5
20-24	2.5	0.7	0.7

Source: Table B-5; Wieland et al. 1977; and Murdock and Leistritz 1979.

Estimating the Residential Location of In-migrating Population

Once the total in-migrating population resulting from a new project has been estimated for a given year, it is necessary to allocate the new population to places of residence within the impact area. Generally, potential places of residence can be limited to existing communities, but, in some areas, new towns also may need to be included in the analysis. In a few regions, a substantial portion of the in-migrants may locate in rural areas and, in such cases, this possibility should be taken into account in the analysis.

Predicting residential location in connection with large energy development projects is inherently difficult. Settlement patterns may hinge on a few key private and public sector decisions, such as provision of service infrastructure or location of housing projects. Most impact analyses have employed either gravity models or judgmental analyses in predicting residential location. Both of these approaches have strengths and limitations.

Gravity models utilize two major variables in estimating residential patterns: (1) a community's population; and (2) its distance (or travel time) from the project site. Data concerning worker settlement patterns associated with similar projects are sometimes used to calibrate the gravity model. The major strength of the gravity model is its reliance on objective, measurable attributes in estimating the proportions of each worker type likely to locate in each area community. Its weaknesses arise in large measure from the inability to directly incorporate a large number of other community attributes (e.g., condition of roads, plans for housing developments, and capacity of public service infrastructure) that may affect settlement patterns.

Judgmental analyses rely on qualitative assessment either by the analyst or by knowledgeable local observers. Such factors as available housing and service structures are used to differentially weight communities as potential settlement sites. This approach has the advantage of providing for input of local knowledge, but has the disadvantage of having its accuracy determined by the reliability of local perceptions (Leistritz and Murdock 1981). The results of such analyses are not readily reproducible (i.e., by a different analyst), and the perceptions of local observers may be influenced by civic pride and related factors.

Because of the counterbalancing strengths and weaknesses of the gravity and judgmental approaches, some analysts feel that the two techniques can be usefully combined. In such a modified gravity model, the projected residential locations computed through the basic gravity equation may be modified on the basis of a judgmental analysis of local conditions. (For an example of this approach, see Leistritz et al. 1982a).

In estimating worker settlement patterns, the analyst should bear in mind that local officials, planners, and other groups close to the situation will often have definite opinions concerning the settlement patterns that are likely to result from project development. Input should be obtained from such groups whenever practical, but possible biases need to be recognized.

The residential allocation procedure recommended for use in this study is a modified gravity model approach. In this approach, a gravity equation is used to estimate an initial distribution pattern (share to each community) for each type of in-migrating population. These shares may subsequently be modified based on specific information concerning local conditions (e.g., condition of roads and plans for housing development).

The gravity equation employed was developed by Wieland et al. (1979), based on an extensive analysis of residential patterns of coal industry workers in the Northern Great Plains States. Separate equations are employed for construction and operation workers; these equations reflect the propensity of construction workers to locate in the larger cities in an area and to commute greater distances to work. The equations are:

Construction: $A = \dfrac{P^{0.612}}{D^{0.598}}$

Operations: $A = \dfrac{P^{0.452}}{D^{0.656}}$

In these equations, A = a community's relative attraction for workers, P = the community population, and D = the distance between the community and the project site. Allocation factors for each community are determined by summing the A values for all communities and taking a ratio of each community's A value to the total A value for all communities.

The application of the gravity model can be illustrated through a simple example. Suppose the impact area has three communities with the following attributes:

Community	Population	Distance (to project site)
A	1,500	20 mi
B	800	5 mi
C	40,000	40 mi

Using the construction worker model, the calculations are:

$$Aa = \frac{1500^{0.612}}{20^{0.598}} = 14.65$$

$$Ab = \frac{800^{0.612}}{5^{0.598}} = 22.84$$

$$Ac = \frac{40,000^{0.612}}{40^{0.598}} = 72.18$$

$$\Sigma = 109.67$$

The resulting allocation factors are:

$$\text{Community A} = \frac{14.65}{109.67} = 0.1336$$

$$\text{Community B} = 0.2081$$

$$\text{Community C} = 0.6582$$

Similar allocation factors can be computed for the operations work force. The allocation factors for construction and operations work forces are then entered onto Worksheet No. 1 (Step 5).

For the secondary workers, data that would enable empirical estimation of allocation factors are not available. Recent case studies of energy impact areas, however, suggest that the residential distribution of secondary workers is probably intermediate between that of construction and operations work forces (Gilmore et al. 1982; Leistritz and Maki 1982). Such distribution patterns are assumed in the application of the assessment procedure. As with other components of the assessment procedure, final coefficients should be evaluated in light of specific local conditions and can be modified as appropriate.

Once the distribution of project-related population among communities has been estimated, the total population of individual communities can be computed. Estimating total community population requires an estimate of the baseline (without project) population. Baseline projections are estimates of the socioeconomic conditions likely to prevail in the study area if the proposed project is not developed. Baseline projections can be compared with the impact (with project) projections to determine the effect of the project on the socioeconomic indicators of interest. They are used in this procedure to derive final population estimates for communities of interest. For purposes of this study, it is assumed that baseline population projections are available from secondary sources (county or regional planning groups, State agencies, universities). If acceptable baseline projections are not available, they can be developed using principles and procedures outlined in a number of standard sources (for examples, see Chalmers and Anderson 1977; Denver Research Institute 1979; Leistritz and Murdock 1981).

In developing baseline projections or evaluating projections prepared by others, it is critical to consider carefully all the forces likely to influence the future patterns of population growth or decline in the area. If other resource development projects are under way or proposed in the area, the effects of these projects should be considered in developing baseline projections. Above all, the analyst should avoid simply assuming a static, unchanging population for the study area unless specific analyses indicate that this is, in fact, the most probable future pattern.

The procedure for estimating total community population is presented in Worksheet No. 1 (Step 5). The same procedure can be utilized to project total population for the impact area (region) provided that suitable baseline projections are available.

Estimating Housing Requirements of In-migrating Population

The sixth and final step in the assessment procedure involves the projection of housing requirements for the in-migrating population. The recommended procedure relies heavily on actual worker housing patterns observed for coal mine and power plant projects at various sites in the Western States. Housing patterns that appear typical for each of the three worker types are presented in Table B-7. These housing profiles are based on data from 14 construction sites and 14 coal mine and power plant operations work forces. More recent studies of changes in the housing stock in Gillette and Rock Springs, Wyoming, during the period 1970-1980, report similar findings (Table B-8). When examining Table B-8, bear in mind that, while both communities experienced large-scale energy development projects during the 1970's, the composition of the respective work forces differed substantially. While energy-related employment in the Gillette area was dominated by coal mine operations and secondary workers, the Rock Springs area experienced a substantial influx of construction workers.

The analysis of housing requirements (and other land service and infrastructure needs) could be completed for all communities within reasonable commuting distance of the project. Generally, however, this step would be performed for those communities that are projected to have significant project-related population growth. While any criterion for defining significant project-related population effects is necessarily arbitrary, one rule of thumb that could be used is to perform community-specific analyses only for those places in which project-related population growth is expected to be 10% or more of the baseline population level. Because the housing profiles presented in Table B-7 appear to be representative values applicable to most Western energy projects, these values are incorporated into Worksheet No. 2 (Step 3) as standard values. These coefficients should be evaluated in light of specific local conditions and modified if appropriate.

The assumed housing requirements are used in conjunction with the number of workers by type to project the number of additional housing units by type required for a given community in a given year. The same procedure can be applied at a regional level. If the construction work force is expected to be very large relative to the operations work force, it will probably be desirable to constrain the estimate of the two types of permanent housing units (houses and apartments) during the construction phase. Thus, construction of these types of housing would be limited to the number of such units required, on the average, during the first 2 yr after construction is completed.

Table B-7. Housing requirements for in-migrating
workers.

	Percent by type of worker		
Type of housing	Construction	Operations	Secondary
House	15	60	40
Apartment	10	20	33
Mobile home	60	20	27
Other[a]	15	0	0
	100	100	100

a Includes various temporary housing facilities, such as
   company-provided single status housing (man camps), recrea-
   tional vehicles, sleeping rooms, and motel rooms.

Source: Mountain West Research, Inc. 1975; Wieland et al.
         1977.

Table B-8. Change in housing stock, Gillette and
Rock Springs, Wyoming, 1970-1980.

	Gillette		Rock Springs	
Housing type	Number	Percent	Number	Percent
Single family	1,199	52.8	1,062	35.9
Multi family	510	22.5	163	5.5
Mobile home	561	24.7	1,733	58.6
Total[a]	2,270	100.0	2,958	100.0

a Does not include such temporary housing facilities as
   man camps and recreational vehicles.

Source: Browne, Bortz, and Coddington 1981a,b.

SUMMARY OF ASSESSMENT PROCEDURE

The purpose of the demographic impact projection procedure is to estimate the effects of a given energy development on population, population profile, and settlement patterns. The assessment utilizes an employment mulitiplier approach to project the effects of the project on employment. The projections of employment requirements are tempered by considerations of the local area, its labor force, company policy, and other factors to determine requirements for in-migrating workers. A profile (age and sex) of the estimated in-migrating population is developed. The final estimate is for project-induced population change for the impact area. The residential allocation analysis then utilizes a combination of gravity model and judgmental analysis to project the distribution of the population change among local jurisdictions (counties and municipalities). Finally, baseline population changes, together with estimated characteristics of the new population, are utilized to project requirements for additional housing.

APPENDIX C. IDENTIFYING POTENTIAL CONFLICT ZONES

INTRODUCTION

As development proceeds within a coal or oil shale development region, some towns will grow enough in size to eventually become major centers, others will grow only a moderate amount, and some will not grow at all. Occasionally, entirely new towns will be built. The factors that resource managers should consider in determining the potential conflict areas on which to focus efforts to guide land use change and direct human activity are discussed below.

FACTORS AFFECTING GROWTH OF TOWNS WITHIN A REGION

Initial Size

The larger the town, the more attractive it will be to most newcomers because it will offer more services, entertainment, and probably more accommodations at the outset of development.

Location

Usually the larger towns in a region are already located on or near major highways. Given two towns of the same size, the town closest to a regional city is usually more attractive to newcomers.

Distance to Work

Any distance of up to 1-hr commuting time usually is considered acceptable to mine employees. Factors influencing attractiveness of towns at greater distances are size, location near a major highway, price of housing, and cost of commuting.

Sociocultural Environment

Some towns may be too rural or conservative in nature to be attractive to incoming workers. Given two towns of the same size, one predominantly agricultural and the other predominantly commercial, new workers usually will prefer the more commercial town.

Location of New Housing Built by Industry

In general, industry will build housing in towns that workers prefer according to the attractiveness factors listed above. However, local governments may want to spread growth over several towns to reduce the severity of impacts on a single town. In this case, the choice of how much housing to locate in which community will be directed by formal or informal agreement between the industry and the local governments. There may be a conscious effort to counter the natural gravitation toward certain towns; resource managers should work with planners in order to anticipate these growth patterns.

Construction of New Towns

Occasionally, the population influx is so large, relative to the size of existing towns, that industry will choose to build a completely new town for its workers. Such towns may be established in very rural areas (e.g., Wright, Wyoming) or they may be constructed around an existing hamlet (e.g., Parachute, Colorado). Factors determining the location of new towns include:

- sufficient private land

- sufficient water supplies

- distance to a major highway

- commuting time (within 1 hr of the work site)

- high probability that other companies will develop mines or projects close enough that growth and stability of the town will not be entirely dependent on one company or one mine.

Given maps showing public and private land ownership, location of present and probable mining projects, and information about the attraction factors of each community, local government officials and planners can predict, with fairly high accuracy, the communities that will become major or minor growth centers, which communities will not grow at all, and where new towns might be developed. Resource managers should also prepare their own rough projections of such distribution, however. The preceding criteria and the projection techniques in this workbook will give resource managers a much needed start toward more effective participation in shaping the development scenario to incorporate fish and wildlife values in land use decisions.

FACTORS THAT MAY INDICATE POTENTIAL CONFLICT AREAS

Many factors influence the direction and types of growth in an expanding community. Listed below are several conditions that indicate areas where attention needs to be focused if fish and wildlife concerns are to be a part of future land use patterns.

Towns

River valley land. Steep slopes, gullies, floodplains, and related
natural features may constrain expansion of housing and related construc-
tion. Towns in narrow valleys may have definite topographical limits to
growth. In hilly country, the flat river valleys and mesa tops are pre-
ferred construction sites. River valleys typically provide key wildlife
habitat, however, and increased impervious surfaces in such valleys will
affect stream flow and aquatic systems. River valley lands are often areas
of conflict between development and resource conservation interests.

Leapfrog development. A community may be blocked from expanding in
one or more directions because it is bounded by public land. Recent changes
in regulations have made it possible for the U.S. Bureau of Land Management
(BLM) to sell land at fair market value for community development. However,
if developers prefer to deal with private owners, town expansion may leap-
frog over a BLM-owned section. Similarly, when private owners of large
tracts of land bordering a growth community elect not to develop their land,
growth often proceeds (sometimes in strange shapes) around the borders.
Leapfrog development can be a problem because habitat loss, alteration, or
degradation will go well beyond the acreage directly affected. Resource
managers usually support growth management and planning aimed at keeping
new development in as compact an area as possible.

Strip development. A certain amount of growth will always occur along
highways and roads. Typically, a number of commercial and light industrial
enterprises (e.g., motels, automobile dealerships, concrete plants, and re-
pair shops) will locate along highway frontage as a community expands.
Often, there will be one or two rows of residential housing behind the
frontages. Limiting such strip development is usually the responsibility
of the county. If there is no county land use policy, strip development
may proceed for miles. If two growing towns are reasonably close to each
other, a continuous strip may eventually link the two towns. Such devel-
opment can have serious impacts on wildlife, especially if the road bisects
a significant habitat area, such as winter range or a migration route.

Extended water and sewer lines. When new water and sewer lines and
facilities are designed and planned, it is usually in conjunction with a
master plan for community growth. Wherever lines extend beyond the central
site, growth is certain to follow where hookups are available. Resource
managers should be alert to utility plans, especially where new lines indi-
cate development in key habitat areas or close to streams.

Annexation policy. Incorporated communities can annex lands contiguous
to their boundaries. When communities are growing, they usually try to in-
crease their tax base by annexing lands that will most likely be developed
for housing, commerce, or industry. Alternatively, they may refrain from
annexing contiguous lands that will add to the cost of municipal services
without providing any significant revenue. This can lead to irregular town
boundary lines and leapfrog development.

Towns experiencing rapid growth usually require developers within city limits to provide infrastructure that meet certain standards (e.g., streets, water, sewerage, and utilities) at their own expense. Developers seeking to avoid these requirements may build outside the city limits, thus creating suburbs. Some towns adopt a policy of annexing large areas of surrounding land in advance of growth; other towns annex only after developments have been constructed to standard regulations and residents have petitioned for annexation.

Resource managers should be aware of land annexation policies. It is important that local and county officials are made aware, very early in the planning stage, of situations where areas within the sphere of influence of a town are environmentally sensitive or critical for target species. Annexation policy can be guided accordingly. In some regions, there will be better control over key lands from a resource management perspective if they are within the municipal boundaries; in others, there will be better management if the county has authority over the lands.

Sphere of Influence

The sphere of influence of a town is the area beyond the city limits, but within some reasonable distance, that will be most directly affected by growth. As a town grows, its sphere of influence keeps expanding outward. Land use changes in this area will be determined primarily by the following six factors:

Official annexation zone. The official annexation zone, which lies 1 to 3 mi from the town boundary, depending on the State, is the region in which a town may annex land. As soon as one parcel of land is annexed, the annexation zone automatically extends out from the new town boundary. It is customary for counties and municipalities to have a joint review process for permitting developments within the annexation zone. Key habitat areas in such areas should be identified early so that needed protective measures can be considered.

Sites for municipal public works facilities. Sites for water intake and treatment plants, sewage treatment plants, sanitary landfills, airports, cemeteries, and other facilities may be located some distance from a town. Planners may have little choice in recommending suitable sites for such facilities, because topography and land ownership may constrain choices. While such facilities do not require large quantities of land, they nevertheless can be significant sources of impacts. For example, access roads to these facilities may encourage new recreation patterns, especially use of off-road vehicles. Harassment of wildlife and increased poaching can also occur. Resource managers should be aware of proposed sites and be able to point out potential conflicts between such development of the site and fish and wildlife concerns.

Sites of unregulated rural development. Some private landowners will consider trailer courts, subdivisions, and commercial or even industrial uses for their lands. Whether or not such development can occur will depend on the county land use management policy and accompanying regulations.

286

If there is no policy or the policy is not enforced, development may occur in areas that are critical to key wildlife species, populations, or communities. Of special concern are riparian lands. These are usually privately owned and highly susceptible to impacts from development, particularly near towns. If key wildlife lands are identified early, county land use policy and regulations can be used to prevent development on these lands. Resource management will be more difficult in the absence of a county land use policy when new rural development will occur.

Recreational use areas. Disturbance to wildlife and vegetation from dispersed human activities is usually more concentrated closer to town. Certain facilities, landscapes, or topography attract recreational use. Examples include water bodies, hills accessible for off-road vehicle use, scenic areas for hiking or camping that can be reached from a main or secondary road, areas noted for arrowheads, and places suitable for target practice. These areas can usually be identified by local residents, planners, or city recreation officials. Where such areas are key wildlife habitat, strategies for protection and alternative use areas must be planned in advance of the population growth and presented to local and county officials, planners, and the public when recreational activity patterns can still be influenced.

Planned recreational areas. Large city-county parks are usually located near the edge of town. If there are amenities, such as boating and camping, these parks also will attract users from elsewhere in the region. Parks often increase the attractiveness of surrounding lands for residential development. Because parks can also be used to help preserve critical habitat for some species, they can be useful tools for resource managers.

Ad hoc trailer camps. Temporary workers may prefer to live in ad hoc trailer camps rather than in a trailer court or rented room. In some areas, workers tend to cluster in groups of three to six trailers in camping grounds, off secondary or dirt roads near towns, or on rented space on private property. Ad hoc trailer camps can be potential growth shapers and a source of disturbance to local wildlife. The pollution from trailer wastes and harassment of wildlife by dogs are often problems, and camp residents may harass or poach local wildlife populations.

Rural Areas

There are several critical growth shapers in outlying areas that are potentially adverse to fish and wildlife. These factors can be anticipated and the impacts avoided or mitigated.

County land use policy. Some counties do not have any land use controls; others have developed very strict controls. Support of community leaders and business groups for controls is more likely to occur in regions with a tourist or recreation economy. Similarly, agricultural and ranching areas may develop controls or policy designed to protect key watershed and grazing areas. The less the political orientation toward such controls, the greater the initiative that is needed from resource managers to recommend protection of key habitat areas through county plans and regulations.

Location of existing roads. Development on private lands will gener-
ally be near existing roads in rural areas. All road networks are a source
of off-road vehicle access and poaching, as well as potential road kill
problems. Rural roads that intersect critical habitat can be a problem
even if current use of these roads is limited.

Temporary construction worker camps. If the number of temporary work-
ers is very large in relation to the permanent work force, companies may
build temporary worker camps, which may hold as many as several thousand
persons. They may be located at the construction site or somewhere between
the site and the nearest main town. Depending on the length of the con-
struction phase and the number of mining projects within the area, these
temporary camps may actually be in place for 5 to 10 yr. They do not occupy
large areas of land and are usually required to meet U.S. Environmental Pro-
tection Agency regulations for pollution control. However, they often are
a subject of concern for resource managers. Traffic between the camps, the
project site, and the town can be heavy, resulting in road kills and poach-
ing problems. In the winter, loss of big game from predation by dogs can
be heavy in the vicinity of such camps. Companies plan the location of tem-
porary camps about 6 mo before the construction phase begins, and they are
usually willing to take wildlife needs into consideration if they have ade-
quate advance information.

Recreational development. As the population increases, a market de-
velops for resorts, hunting lodges, guest ranches, and summer homes. This
usually occurs after population in the major towns has stabilized, about
8 years after a project starts. The location of such development is deter-
mined by topography, land ownership, and existing facilities. For example,
sites preferred for summer homes often are adjacent to National forests or
National park lands with lakes and recreation opportunities. A secluded,
scenic tract of ranch land may be quickly developed into a resort complex.
Such developments may be up to 4 or 5 hr away from population centers. Re-
source managers that are alert to early signs of such development can work
with developers to reduce negative impacts through design, engineering, and
management plans.

Federal activities. The U.S. Forest Service may decide to permit log-
ging activities or establish recreation areas in National forests in response
to needs of the new population. This, in turn, may trigger construction of
new roads, homes, and services. This may mean the expansion of a small
crossroads hamlet or the construction of a few motels along the access road
or involve a major project, such as a ski area, that will generate an en-
tirely new set of population impacts. Similarly, BLM may permit new min-
ing, logging, or other developments on its land in response to population
growth. Federal agencies will evaluate the possible impacts of such pro-
posals on the general area.

Demand for construction materials. There usually is a large demand
for sand, gravel, and construction rock in a rapid growth area, and the
materials are taken where available. Sand and gravel deposits are fre-
quently close to or in watercourses. Removal can lead to siltation prob-
lems and loss of spawning areas. Quarrying operations result in new access
roads, traffic, dust, and noise.

Linear Facilities

Linear facilities, such as transmission lines, pipelines, and railroads, are regional and transregional in nature. They may be developed to service industrial projects and community expansion within the region or, as is the case with major gas pipelines, they may merely pass through a region. Their siting will be influenced primarily by topography and cost. In mountain country, there may be only one or two possible corridors for long distance utilities; in plains country, there is usually more flexibility in corridor location. Companies prefer corridor alternatives with the lowest construction and maintenance costs.

Local land use requirements. Some counties require that transmission lines be visually unobtrusive. Other counties require the grouping of utility lines in corridors to minimize access roads. If a county has a land use policy or permit system, it may also require that environmental and wildlife considerations be taken into account in siting. Resource managers should be aware of whether or not such a county planning policy exists.

If rights-of-way must be acquired across Federal land, an environmental assessment will be required. This can be a tool to incorporate wildlife considerations into the routing and design. Most Federal agencies will not grant a permit unless the proposed route meets with the approval of local government authorities. If early notification of corridor routings is also given to resource management agencies for review, corridor impacts can be avoided or mitigated.

State highway department plans. Upgrading and construction of highways, bridges, and bypasses are ongoing activities of State highway departments, in consultation with the Federal Government and local authorities. Plans may be made well in advance of construction. Because of long lead times in highway planning, original plans in rapid growth areas often become quickly outdated. For wildlife mitigation purposes, State highway departments should be approached (as independent agencies), with consideration of key habitats and migration routes emphasized as early as possible in the highway planning process. The type of fencing used and the width of rights-of-way should be considered when upgrading or constructing highways.

County highway department plans. County highway design and construction are usually contracted out to a consulting engineer and a local contractor. The primary concerns to the county in road location will be to minimize costs and provide school bus service to rural residents. Wildlife concerns can be taken into consideration, but only if appropriate information is readily available to the contracting engineer. It should be emphasized that, even if the county has such information, it is not always automatically given to contracting firms. Resource managers may need to encourage both county officials and contractors to consult with them prior to making recommendations or commitments on county infrastructure.

APPENDIX D.   STANDARDS FOR LAND USE CONVERSION

Eight sources of conversion standards or partial conversion standards are shown in Table D-1.   These standards were generated from reports of State agencies concerned primarily with meeting social and community service needs, Federally sponsored research for either community impact awareness or environmental assessment purposes, and land use profiles of communities planning for energy development.   Table D-1 presents the land use conversion variables most frequently reported, including the standard and an acreage figure (per 1,000 population) where available.

After these data were reviewed, the standards set forth in Table D-2 were selected as representative guidelines for projecting land use changes in rapid growth areas. The State agency guidelines examined most closely were those prepared by the Colorado Department of Local Affairs (1981) and the Montana Department of Social and Rehabilitative Services (1980).   The Federally sponsored research of greatest utility was that by Briscoe, Maphis, Murray, and Lamont, Inc. (1978) and the U.S. Department of the Interior (1977).   Finally, plans and land use data of Powder River County, MT (1981); Longmont, CO (Briscoe, Maphis, Murray, and Lamont, Inc. 1978); and Rangely, CO (undated), were reviewed.

In addition to the urban impact categories shown in the tables, there are several categories of land use impacts that may accompany economic growth in an energy development scenario.   These include roads, railroad spurs, power lines, pipelines, telephone lines, and water impoundments. Table D-3 shows sample values from environmental impact statements on coal mining activities (U.S. Department of the Interior 1978a-d, 1979a-e).

Table D-1. Planning standards for rapid growth areas.

Land use category	State agency — Colorado[a] Standard	State agency — Colorado Acres per 1,000 pop.	State agency — Montana[b] Standard	State agency — Montana Acres per 1,000 pop.	Federal study — EPA[c] Acres per 1,000 pop.	Federal study — DOI[d] Acres per 1,000 pop.	Community study — Powder River[e] Acres per 1,000 pop.	Community study — Longmont[f] Acres per 1,000 pop.	Community study — Rangely[g] Acres per 1,000 pop.
Housing	2.75 persons/unit 57% single family (4 units/ac) 17% multifamily (15 units/ac) 26% mobile home (8 units/ac)	52 4 12			40/56[h] 12.5/7.5[j] 1.3/0.3[l]	-	44[i] 3.8[k] 2.1[m]	53	43.3 14.0 6.1
Parks/recreation	--	6.2	Neighborhood park District park Regional park	25.5 2.0 15.0 25.5	10	10	10	6	24.4
Schools	140 ft²/student 25 students/classroom 200 students/1,000 population; 9 classrooms/1,000 population 28,000 ft²/1,000 population 6.6:1 = land:building	4.3	Elementary: 1 school/ 500 students, 12-14 acres Junior high: 1 school/ 800 students, 24-26 acres Senior high: 1 school/ 1,000 students, 40-42 acres	-	Elementary: 2.8 Secondary: 3.2	6	Elementary: 1.1 Secondary: 0.32	-	6.2
Sewage treatment	120 gal/person/day	1	168 gal/person/day 1 acre sewage lagoon/1,000 persons	1	1	1	1	-	-
Water supply	200 gal/person/day	1	517.5 gal/person/day 0.2 acre-ft/person/yr	-	1	1	1	-	-
Solid waste	950 T/yr/1,000 persons generated, requiring 0.5 acres/yr (x 20-yr site life)	10	--	-	1.67	-	10/1.69[n]	-	-
Hospitals	Access to 4 beds/ 1,000 population	0.25	--	-	0.25	0.25	0.25	-	-

Table D-1 (Continued)

Land use category	State agency				Federal study		Community study		
	Colorado[a] Standard	Acres per 1,000 pop.	Montana[b] Standard	Acres per 1,000 pop.	EPA[c] Acres per 1,000 pop.	DOI[d] Acres per 1,000 pop.	Powder River[e] Acres per 1,000 pop.	Longmont[f] Acres per 1,000 pop.	Rangely[g] Acres per 1,000 pop.
Medical, mental health, social services	1,500 ft²/1,000 population 4:1 = land:building	0.14	--	--	--	--	--	--	--
Libraries	0.7 ft²/person plus 100 ft² start-up space 4:1 = land:building	0.14	0.7 ft²/person	0.14	0.14	0.14	0.14	--	--
Shop, maintenance, services	700 ft² garage plus 4,100 ft² land and storage/ 1,000 population (total = 4,800 ft²/ 1,000) 1.6:1 = land: building	0.1	--	--	--	0.03	--	--	--
Fire protection	1,000 ft²/1,000 population 4:1 = land: building	0.09	--	--	0.07	0.07	0.07	--	
Administrative space	800 ft²/1,000 population 4:1 = land:building	0.08	--	--	0.034	0.004	0.034	--	0.81^o
Public safety	400 ft²/1,000 population 4:1 = land: building	0.04	2.1 officers/1,000 population; 100 ft²/officer (total 210 ft²/ 100 population) 4:1 = land:building	0.02	0.06	0.06	0.06	--	

Table D-1 (Concluded).

Land use category	State agency				Federal study		Community study		
	Colorado[a]		Montana[b]		EPA[c]	DOI[d]	Powder River[e]	Longmont[f]	Rangely[g]
	Standard	Acres per 1,000 pop.	Standard	Acres per 1,000 pop.	Acres per 1,000 pop.	Acres per 1,000 pop.	Acres per 1,000 pop.	Acres per 1,000 pop.	Acres per 1,000 pop.
Detention facility	500 ft²/1,000 population; 3:1 = land: building	0.03	--	--	-	-	-	-	-
Commercial	--	-	--	--	1.17	-	46.2	6	3.58
Industrial	--	-	--	--	12	-	2.3	5	6.10

a Colorado Department of Local Affairs (1981).
b Montana Department of Fish, Wildlife, and Parks (1980).
c Briscoe, Maphis, Murray, and Lamont, Inc. (1978).
d U.S. Department of the Interior (1977).
e Powder River County, Montana (1981).
f Briscoe, Maphis, Murray, and Lamont, Inc. (1978).
g Rangely, CO (undated).
h 40 acres in permanent units in construction phase/56 acres in operations phase.
i Permanent.
j 12.5 acres in temporary units in construction phase/7.5 acres in operations phase.
k Temporary.
l 1.3 acres in other units in construction phase/0.3 acres in operations phase.
m Other
n Landfill/concentrated.
o All community services.

293

Table D-2. Recommended land use conversion standards for energy impact areas.

Land use category	Acres per 1,000 population
Housing	
Single family (detached)	4 units/acre[a]
Multifamily	15 units/acre
Mobile homes	8 units/acre
Other	15 units/acre
Parks/recreation	10[b]
Schools	6[b]
Sewage treatment	1
Water supply	1
Solid waste	10
Hospitals	0.25
Medical, mental health, social services	0.14
Libraries	0.14
Shop, maintenance services	0.1
Fire protection	0.07[b]
Administrative space	0.05[c]
Public safety	0.06[b]
Detention facility	0.03
Commercial	4[c]
Industrial	6[c]
Total[d]	38.75

a   Only space standards (units per acre) are suggested because the distribution of housing types should be calculated for each project (Worksheet No. 2, Step 3).

b   Most frequent value (Table D-1).

c   Midrange value (Table D-1).

d   Excluding housing, streets, and rights-of-way.

Source: Midwest Research Institute.

Table D-3. Acreage requirements for oil shale and ancillary development.

Facility	Acres required
Mine surface structures	100/mine
Power plant	1.5/MW
Power line	
230 kV	18/mi
138 and 69 kV	12/mi
Smaller	6/mi
Telephone line	0/mi[a]
Road	
175-ft right-of-way	21/mi
100-ft right-of-way	12/mi
Railroad line (157-ft right-of-way)	21/mi
Gasification plant (includes pipeline, power, and access)	1,500/plant
Conveyor system	10/mi
Per million tons of coal mined	100
Population increase (general: see worksheets for specifics)	100-145/1,000 persons

a Assumed either within road, rail, or power right-of-way corridor.

Source: U.S. Department of the Interior (1979e).

APPENDIX E.   USING MAPPING KEYS AND SELECTING EVALUATION SPECIES

MAPPING KEYS

Table E-1 is a sample key used in the State of Utah for mappable, high-value habitat areas (Dalton, pers. comm.). Other States have used different codes. For example, a study by Rippe and Rayburn (1981) of land use impacts on Wyoming's big game herds identified 12 types of seasonal habitat in Wyoming: summer (s); critical-summer (cs); summer-yearlong (sy); critical-summer-yearlong (csy); winter (w); critical-winter (cw); winter-year-long (wy); critical-winter-yearlong (cwy); yearlong (y); critical-yearlong (cy); parturition (p); and intermediate (i). Another example is the surface cover classification system used in North Dakota by the U.S. Bureau of Land Management, which follows the code shown in Table E-2.

SELECTING EVALUATION SPECIES

The workbook depends on accompanying use of a habitat evaluation procedure. The U.S. Fish and Wildlife Service (1980) has prepared guidance on this subject and has a Habitat Evaluation Procedure (HEP) that can be used in the completion of several steps in this workbook.

When the evaluation procedure used is a species-oriented methodology, selection of evaluation species is an important step. Considerable guidance on species selection, including suggestions on using a guilding (species grouping) approach, are contained in HEP references and other U.S. Fish and Wildlife Service publications and will not be repeated here. The term "evaluation species" is defined as meaning individual species, a species group (guild), a species life stage, or a species life requisite. Evaluation species should be selected as part of the preassessment activities and the selection should be agreed on by all members of the evaluation team.

This workbook procedure is facilitated if the resource manager can construct a model or method whereby existing and future habitat quality for the evaluation species in areas where land use or human activity change is projected to occur can be predicted. Models can help the user:

- document an evaluation
- establish the credibility of an evaluation
- provide a record of the basis of impact evaluation predictions
- synthesize habitat information for species of interest to local decisionmakers
- provide guidance for mitigation and enhancement measures.

Table E-1. Sample key for mappable, high value habitat areas.

Explanation

Aquatic use areas:
The first letter identifies one of three use area rankings: c, critical;
h, high priority; and s, substantial value. The second group of letters
identifies the primary type of fishery for which a water is managed: cw,
cold water fishery; ww, warmwater fishery; and ng, nongame fishery. The
first number identifies the stream section, and the second number iden-
tifies one of the stream classes defined by the State's water plan (if
applicable). The last letters identify a need for yearlong protection
of this water. For lakes, the notations are the same as for stream sec-
tions except that the numerals are replaced with the name of the body
of water. Game fish species that inhabit the stream sections or lakes
can also be identified on the map overlays.

Terrestrial use areas: The first letter identifies one of the three use
area rankings: c; h; or s. The second group of letters denotes the animal
species of concern:

Big game   Upland/small game

 b = bison   bg = blue grouse
bs = bighorn sheep   ck = chukar
bb = black bear   mc = mountain cottontail rabbit
 c = cougar   '   dc = desert cottontail rabbit
 e = elk   du = mourning dove
mg = mountain goat   rnp = ring-necked pheasant
 m = moose   rg = ruffed grouse
 d = mule deer   sa = sage grouse
 p = pronghorn   sh = snowshoe hare
                                  wa = waterfowl

Other game species, such as squirrel, quail, turkey, and furbearers, in
a specific area may be added to the list above as appropriate.

Nongame species of interest include raptors (r), golden eagle (ge), and
bald eagle (be). Any threatened or endangered species would be identi-
fied by name.

The third set of letters gives season of use (e.g., wt, winter; su,
summer; rt, rutting season); the numbers are dates for various use
areas or activities, when a species is normally present or partici-
pating in an activity. These numbers denote the period when protec-
tion from disturbance is needed.

Wildlife use areas	Use area ranking		
	Critical	High priority	Substantial value

Aquatic use areas

Wildlife use areas	Critical	High priority	Substantial value
Stream sections and lakes	c-cw-2-1-yl		s-cw-2-4-yl

Terrestrial use areas - big game

Wildlife use areas	Critical	High priority	Substantial value
Wetlands, riparian zones, seeps, and springs	Symbols should show entire area and a buffer zone of at least 0.25 mi for these areas		
Bison	Winter range C-b-wt 12-1 to 4-15 Summer range c-b-su 4-15 to 11-30		Herd distribution s-b-yl
Bighorn sheep	Rutting season (tallus slopes) c-bs-rt 11-1 to 12-31 Lambing season (tallus slopes) c-bs-la 5-1 to 6-15	Tallus slopes (ewes and lambs) h-bs-yl 1-1 to 12-31 Mesa tops-- 1 mile radius (rams) h-bs-yl 1-1 to 10-31	Herd distribution s-dbs-yl s-dbs-yl
Black bear			Population distribution s-bb-yl
Cougar			Population distribution s-c-yl
Deer (mule)	Winter range c-d-wt 11-1 to 5-15 Summer range c-d-su 5-16 to 10-31	Winter range h-d-wt 11-1 to 5-15 Summer range h-d-su 5-16 to 10-31	Herd unit s-d-yl

Wildlife use areas	Use area ranking		
	Critical	High priority	Substantial value
Elk	Winter range c-e-wt 11-1 to 5-15	Winter range h-e-wt 11-1 to 5-15 Summer range h-e-su 5-16 to 10-31	Herd distribution s-c-yl
Mountain goat			Herd distribution s-mg-yl
Moose	Yearlong c-m-yl 1-1 to 12-31		Herd distribution s-m-yl
Pronghorn	Winter season c-p-wt severe snow conditions Fawning season c-p-fa 5-12 to 6-20	Yearlong range h-p-yl 1-1 to 12-31	Herd distribution s-p-yl
Terrestrial use areas - upland and small game			

Blue grouse	Breeding
	  territory
	  and nest-
	  ing
	(Mountain
	  brush zone)
	c-bg-btn
	3-15 to 6-15
	
	Winter range
	(mature, high
	  elevation
	  stands of
	  Douglas fir)
	c-bg-wt
	12-1 to 2-28
		Brooding area
		h-bg-b
			Population distribution
			s-bg-yl

Table E-1 (Continued)

| Wildlife use areas | Use area ranking | | |
	Critical	High priority	Substantial value
Chukar	Winter range c-ck-wt 12-1 to 2-15 Nesting season c-ck-n 4-1 to 5-30		Population distribution s-ck-yl

Cottontail rabbit
  Mountain cottontail
  found above
  7,000 ft elevation.
  Desert cottontail
  found below
  7,000 ft elevation.
	Nesting season
	c-mc or dc-n
	4-1 to 7-31
			Population distribution
			s-mc-yl

Mourning dove	Nesting season c-du-n 5-1 to 8-31		Population distribution s-du-su

Ring-necked
  pheasant
	Croplands,
	  adjacent
	  riparian
	  areas and
	  wetlands
	c-rnp
	1-1 to 12-31
	
	Nesting season
	c-rnp
	5-15 to 7-15
			Population distribution
			s-rnp-yl

Ruffed grouse	Brooding areas
	(0.25 mi
	  each side
	  of stream
	  courses)
	c-rg-b
	6-1 to 8-15
		Summer range
		(0.25 mi each
		  side of stream
		  courses)
		h-rg-su
		3-11 to 11-30
			Population distribution
			s-rg-yl

Wildlife use areas	Use area ranking		
	Critical	High priority	Substantial value
Ruffed grouse (continued)	Winter range (e.g., clone of mature male Aspen near stream) c-rg-wt 12-1 to 2-28 Drumming log c-rg-dr		
Sage grouse	Strutting grounds and associated brooding area 3-15 to 8-15 Winter range c-sa-wt 11-15 to 3-14	Summer range s-sa-su 8-16 to 11-14	Population distribution s-sa-yl
Snowshoe hare	Nesting season (spruce-fir and lodgepole pine forests) c-sh-n 4-1 to 8-15		Population distribution s-sh-l

<div align="center">Other use areas</div>

Wildlife use areas	Critical	High priority	Substantial value
Waterfowl	Nesting season c-wa-n 3-15 to 7-15	Peak migration (all wetlands, stream courses, ponds, and lakes) h-wa-m 3-15 to 5-15 (spring) 8-15 to 10-15 (fall) Brooding and mounting season (all wetlands, stream courses, ponds, and lakes) h-wa-bm 7-16 to 8-15	Population distribution (all wetlands, stream courses, ponds, and lakes) s-wa-yl

Table E-1 (Concluded).

Wildlife use areas	Use area ranking		
	Critical	High priority	Substantial value
Vultures, accipiters, buteos (hawks only), harriers, osprey, merlin, American kestrel, and owls	Aerie site Species-specific symbols identified on map--protection needed in 0.25 mi radius buffer zone when area is in use	Breeding territory surrounding an aerie site	Population distribution (entire area provides habitat for several species)
Golden eagle	Aerie site 2-15 to 6-15	Foraging areas and prey species habitat h-ge-prey	Population distribution (entire area provides habitat for several species)
Bald eagle	Roost tree 11-15 to 3-15	Winter concentration h-be-wt 11-15 to 3-15	Winter concentration (entire area between 11-15 and 3-15 each year)
Cliff-nesting falcons	Aerie site 3-1 to 6-30	Foraging areas and prey species habitat h-rap-prey	

Sources: Midwest Research Institute; and Dalton, pers. comm.

Table E-2. Surface cover classification system for west central planning unit, North Dakota.

Parameter	Code	Minimum map unit	Comments
WETLANDS			
Riverine	R	All	All rivers or streams with permanent or intermittent surface water.
Palustrine, emergent veg.	PEM	All	Typical prairie pothole with emergent vegetation.
Springs, seeps	PEMS	All	Drainages and sidehills with emergent vegetation. Alkaline surface deposits often evident.
Palustrine, emergent veg.-- drained	PEMD	All	Prairie pothole that has been drained. Ditches often evident.
Palustrine, emergent veg.-- farmed	PEMF	All	Prairie pothole showing evidence of farming (furrows, stubble, bare soil).
Palustrine, open water-- natural wetland	POW	All	Typical prairie pothole with open water.
Palustrine, open water-- manmade wetland.	POWX	All	Impoundments such as dugouts, small dams, and reservoirs.
Palustrine, emergent veg.-- manmade wetland.	PEMX	All	Shoreline vegetation of reservoirs, dugouts.
Lacustrine	L	20 acres	Natural ponds and lakes greater than 20 acres.
Woodlands	WO	0.5 acres	20 to 100% tree canopy closure.
Shrubland	WSL	0.5 acres	6 to 100% shrub canopy closure in areas with less than 20% tree canopy closure.

Table E-2 (Concluded).

Parameter	Code	Minimum map unit	Comments
Native prairie	NP	10 acres	Undisturbed prairie may have 5% shrubs or isolated trees on less than 0.5 acre. Does not include wild hay cropping.
Agriculturally disturbed	AD	10 acres	All active or historic human agricultural disturbances: tilled ground; hay crops; farm-land reverted to native prairie, as evidenced by drainages, fences, and furrows.

Scale of corresponding maps: 1:24,000

HEP is based on models that produce indices of habitat suitability for an evaluation species or an output that can be converted into an index. Such models need not be complex. These models result in a habitat suitability index (HSI), which is a ratio between a value for a habitat characteristic in the study area and the value for that characteristic under optimum conditions.

There currently is only an assumed relationship between HSI and carrying capacity. However, assuming that population ratios are a possible measure of habitat quality, for this workbook procedure, production or density of the evaluation species will probably be the most common result of an assessment (or modeling) procedure. If, for example, a standard for optimum productivity of white-tailed deer in an area is defined as 50 deer/mi^2 and, based on an assessment (modeling) effort, the area under evaluation is estimated to have a productivity of 25 deer/mi^2, the HSI of the study area would be 0.5, or 50% of optimal. If urban development covered 1 mi^2 of the study area, the loss would be 25 deer. If, instead, development occurred not on but adjacent to this same area and deer avoided an area of 0.2 mi^2, the loss would be 5 deer. To continue the example, if the remaining habitat (0.8 mi^2) could be enhanced to raise its productivity by 20%, adverse impacts would be successfully mitigated. Thus, the concept of habitat suitability indices becomes useful in trade-offs mitigating adverse impacts from land use or human activity changes.

Considerable guidance on HSI modeling is available (U.S. Fish and Wildlife Service 1981). To adapt models for use in this workbook, assumptions must be made about the effects of human activity changes (e.g., the presence of people or machines) on habitat suitability for the evaluation species. Some guidance on behavioral avoidance impacts is offered. It is hoped that future efforts can improve these assumptions.

305

APPENDIX F. OFF-ROAD VEHICLE AND SNOWMOBILE USE

DEMAND

Demand for off-road vehicle (ORV) and snowmobile use can be approximated using age-specific participation data. The participation rates and activity days shown in Table F-1 were based on available State data, but do not reflect age categories. The rates shown in Table F-2 were based on available Statewide data that reflected age categories. Snowmobile data did not reflect enough variation by sex to justify separating by population profiles. Area resource managers should consult with State recreation planners and use region-specific data when available.

Table F-1. Percentage of the population participating in off-road vehicle use and snowmobiling and days per year per participant.

	Percentage of participants			Days per year per participant		
	4-wheeling	Motor-biking	Snow-mobiling	4-wheeling	Motor-biking	Snow-mobiling
Colorado, region 11[a]	45.8	22.4	19.1	21.3	28.7	7.9
Wyoming, new population[b]	-	11.7	5.9	-	25.5	2.1
Wyoming, old population[b]	-	11.9	9.6	-	22.7	9.2
Montana, region 3[c]	32.8	15.4	12.8	-	-	-
Montana, State-wide	23.8	18.8	14.8	8.0	14.0	5.0
North Dakota, region 7[d]	-	-	14.1	-	-	10.8

a Includes Moffat, Rio Blanco, Garfield, and Mesa Counties.

b New and old populations in the growth area of Wheatland, Gillette, and Sheridan were surveyed.

c Includes Rosebud, Custer, and Powder River Counties.

d Includes McLean and Mercer Counties.

Sources: Montana Department of Fish, Wildlife, and Parks 1980; North Dakota Parks and Recreation Department 1980; Wyoming Recreation Commission 1980; Colorado Division of Parks and Outdoor Recreation 1981.

Table F-2. Estimated participation rates for off-road vehicle (ORV) and snowmobile use, by age category.

Age category		Estimated percentage participation	Average annual days per participant
ORV use			
Males (years)	12-17	0.15	
	18-24	0.51	
	25-34	0.31	
	35-44	0.21	
	45-64	0.17	25.5
Females (years)	12-17	0.08	
	18-24	0.26	
	25-34	0.16	
	35-44	0.10	
	45-67	0.08	
Snowmobile use			
Males and females (years)			
	12-17	0.10	
	18-24	0.29	
	25-34	0.15	2.1
	35-44	0.14	
	45-64	0.13	

Source: Midwest Research Institute.

Off-road vehicle and snowmobile use in wildlife areas are among the most controversial forms of recreational activity to confront resource managers. A brief review of selected studies is presented below.

OFF-ROAD VEHICLE USE

Birds were found to be the vertebrates most sensitive to ORV influence in a study by Luckenbach (1978). Moderate levels of ORV use (not defined) have resulted in a 50% loss in the number of breeding avian species. Potential impacts on upland game birds were loss of food and cover, destruction of nesting and bedding areas, and harassment. Guzzlers for gallinaceous birds were reported vandalized by ORV users and surrounding vegetation was damaged or destroyed. Luckenbach pointed out that ORV activities affect not only the breeding components of desert avifaunas but, potentially, winter visitant and migrant species as well. Concentrating ORV activity in limited areas that have already been impacted was viewed as the best short

term management alternative. Large prime tracts of habitat with diverse bird communities should be identified and protected to ensure future areas for colonization. Seasonal or statutory closure of areas critical to game, raptorial, endangered, or nesting-restricted species during breeding and fledging or during peak concentrations was deemed important.

Wilshire et al. (1978) reported on the impacts of ORV's on soils and vegetation at over 400 sites in seven Western States. Direct impacts included crushing and uprooting of plants; indirect impacts included modification of the soil so that plant damage was extended beyond the direct impact area and restoration of plant cover was inhibited. Motorcycles impact about 2.5 acres every 50 mi traveled, and four-wheel vehicles impact the same amount of area every 15 mi traveled. As erosion enlarges vehicle paths, accelerated runoff or wind erosion of adjacent areas occurs. Adjacent areas can also be buried by debris eroded from ORV use areas. Furthermore, loss of the upper, more fertile layers of the soil reduces the long term productivity of the land. Suggestions for conserving soils in ORV use areas included replacing hill climbs (or descents) and steep trails with contoured or switchbacked trails, using diversion structures to reduce slope length, and installing nonerodible structures or surfaces to reduce bare soil exposure (e.g., paving trails or installing chainlink fencing and concrete blocks in the trail surface). Banning ORV's from public land in general has been supported by some resource managers (Lodico 1973).

SNOWMOBILE USE

As pointed out by McCool (1978), there have been numerous studies of the impact of snowmobiles on wildlife, but no consensus on these impacts. Contradictory findings on the relationship between big game (deer and elk) movements and snowmobile-generated noise abound. Similar contradictory findings for small game species have been noted by Bury (1978). One problem with regard to identifying noise and visual impacts is defining "impact"; i.e., whether impact means a change in behavior, an increase in the physiological stress level, or a change in population level. Still more difficult is the managerial problem of determining when these changes become "considerable adverse effects," meriting closure or restricting of public lands. The snowmobile issue is made more complex by the fact that most snowmobiling occurs when food supplies are low and the ability of wildlife to conserve energy may be critical to survival. Also, the impact of the relative number of snowmobiles in an area has not been established. Finally, the particular way in which different people use snowmobiles may have an important bearing on impacts.

In general, the major effects on large animals appear to be changes in stress levels and in the daily routine of the animal, with deer being more tolerant than elk of snowmobiles. Light traffic displaces deer from areas immediately adjacent to the trails, but heavier traffic probably has little effect on deer movement (Dorrance et al. 1975).

308

In a 2-yr study on the reactions of deer to people walking and snow-mobiling, Freddy (pers. comm.) found that snow conditions are the determin-ing factor in behavioral avoidance of deer to the presence of people and machinery. In deep snow, deer will stand their ground and tolerate much closer presence. The nutritional status of the deer will also influence their reactions. Freddy found that at minimal levels of disturbance (twice a day every third day on winter range) there was no permanent displacement of deer off the range; responses observed and their distances from the source of disturbance are shown in Table F-3.

Table F-3. Four types of responses of deer and the average distances from the source of disturbance (in meters).

Stimulus	Bedded alert	Standing alert	Rising or ceasing to graze	Running
1 person walking	335 ± 21	334 ± 34	239 ± 30	188 ± 30
2 persons walking	324 ± 22	324 ± 62	253 ± 22	206 ± 26
1 snowmobile	449 ± 57	443 ± 96	338 ± 57	99 ± 34
2 snowmobiles	469 ± 83	444 ± 150	394 ± 143	187 ± 92

Source: Freddy. (pers. comm.).

One interesting observation was that people walking elicited a running re-sponse from the deer 75% of the time, whereas snowmobiles elicited a run-ning response from the deer 50% of the time. One emphasis for management of snowmobiles crossing a winter range to get to a designated snowmobiling area (generally higher elevations provide better snowmobile conditions) is to get the vehicles through the winter range area as quickly as possible, without having operators stop or dismount from their vehicles.

In a 1973-74 study of the effects of snowmobiles on deer, Dorrance et al. (1975) found that deer responded to even very low intensities of intrusion by people and vehicles. Vehicles present per day averaged 10 on weekdays and 195 on weekends. Snowmobile traffic resulted in increased home range size, increased movement, and displacement of deer from areas along trails. Light traffic resulted in displacement; thereafter, increased traf-fic caused no additional response. With light traffic, deer moved about 100 to 200 yd from the nearest trail. During severe winters on poor ranges, such displacement from even small segments of home range may well be detri-mental. During less severe winters, the effect of light snowmobile traffic may be negligible.

Some mention should be made of other adverse impacts on big game from snowmobiles. Abuses may occur in the use of snow vehicles for big game hunting. Two or three machines may be used together to locate animals, with walkie-talkies used for communication. Snow vehicles are also used to herd game to hunters "on point." Regulations prohibiting firearms on snow-mobiles when in use by a hunter would limit their use to retrieving game

taken (Malaher 1967). Harassment of big game may occur, both in season and out. Deer hampered by deep snow may be chased. Hunters on foot, whose animals have been spooked by machines, frequently complain that their hunts are ruined.

Animals of intermediate size exhibit no general response behaviors to snowmobile activity; however, small animals using the air space between snow and the ground surface may die as a result of compaction of the snow and the resultant barrier to movement, plus reduction of the temperature-insulating properties of snow. Reduction in small animal populations in heavily used areas could also reduce predator species (e.g., hawks, owls, and foxes) (Bury 1978).

PEOPLE AND MACHINERY

In terms of behavioral avoidance by wildlife to humans and vehicles in general, Ward et al. (1973) found that a nearby interstate highway had little effect on elk behavior within 300 yd, but that the highway did act as a barrier to elk movement. The major concern was to keep roads away from elk feeding sites on open meadows and slopes and along stream courses. Elk, in this study, preferred about a 0.5-mi distance from people who were camping, picnicking, and fishing when adequate cover buffer zones were available.

Studies of Wyoming's I-80 highway have shown that hunted populations of elk, mule deer, and pronghorn are displaced more by the presence of people walking than by vehicle traffic. Elk were the most sensitive. They preferred to stay about 0.5 mi from people walking and 0.25 mi from traffic. Mule deer were found to prefer a distance of about 200 yd from people walking, but were frequently seen feeding within 50 yd of heavy traffic. Pronghorn were concerned with people walking 200 yd away, but were consistently seen using the area up to a right-of-way fence within 50 yd of traffic (Ward, pers. comm.).

Schultz and Bailey (1978) found that elk in Rocky Mountain National Park, who had experienced little or no hunting activity, were disturbed little, if any, by normal on-road visitor activities. There were longer flight distances from an approaching person than from an approaching vehicle.

Knight (1981) reported that seismic activity in a good elk habitat area in Michigan's Lower Peninsula disturbed elk sufficiently to move them an increased mean distance of 979 yd. The implications of such movement are not serious if elk are not displaced from suitable habitat. It was noted, however, that, in habitat of marginal quality, or in parts of a range bordering agricultural or residential areas, movement resulting from human disturbance could place elk in critical situations. Impacts could include the breakup of a harem during the fall rut or driving a cow near parturition away from a favored calving site. Actual oil well activity (as opposed to blasting) did not affect the movement or distribution of the elk in this study, possibly because the oil well activity was stationary and confined to a 2-acre well pad and the access road.

Decreases in reproduction of deer and elk populations could occur if avoidance of an expanding road system results in a loss of needed forage for the animals. Hunted populations may respond more than unhunted populations, which seem to habituate to humans more readily.

Rost and Bailey (1979) reported that mule deer and elk avoided roads on winter ranges, particularly within about 200 yd of roads. Avoidance was greatest: (1) on ranges east (rather than west) of the Continental Divide (presumably because of greater availability of winter habitat away from the road as a result of less snow accumulation east of the Divide); (2) by deer, when compared to elk; (3) along heavily traveled roads; and (4) for deer in shrub habitats, rather than in pine and juniper habitats.

Craighead and Mindell (1981) studied nesting raptors in a 12-mi^2 area of western Wyoming, now a part of Grand Teton National Park, but a semi-wilderness area in 1947 when intensive nesting surveys were first collected on the raptor population. Both numbers of nesting pairs and nesting success markedly declined between 1947 and 1975. Increases in human disturbance and changes in the natural environment were indicated as major factors causing the decline. Starlings had become abundant and numerous by 1975, and raven densities had increased. There were three red-tailed hawk pairs that nested within 0.4 mi of houses or paved roads but all failed to produce young.

Human presence was suspected as a major factor contributing to lower reproduction of osprey on Yellowstone Lake, compared with that along undisturbed streams (Swenson 1979). Nests beyond 1 km from a campsite were more successful than those closer to a campsite and were as successful and productive as nests along streams.

Hicks and Elder (1979) studied bighorn sheep and recreationists in the Sierra Nevada Mountains of California. They found that hiker trails did not affect sheep movements in the summer range. Bighorn-human encounters were limited to specific locations and did not adversely affect the bighorn population. Regulations that limited the number of hikers per day to 25 and prohibited off-trail hiking and grazing of horses were credited with the successful interaction between recreationists and bighorns.

CROSS-COUNTRY SKIING

Cross-country skiing probably has a greater impact than snowmobiles on wintering wildlife in some areas. Cross-country skiers are more mobile than snowmobilers and are able to get onto winter ranges more easily. Snowmobilers are limited to relatively flat areas of deep snow. As mentioned, studies in Colorado have shown a much greater response from deer to a person on foot (or appearing on foot, as on skis) than to a person on a snowmobile. Cross-country skiing is increasing rapidly, and resource managers should consider educational programs to keep skiers off of winter range.

APPENDIX G.   IN-MIGRATION IMPACT ON BIG GAME FROM ILLEGAL HARVEST

PREDICTING THE PROBLEM

The problem of illegal harvest by poachers existed long before encroachment by new energy developments and accompanying boomtown growth became problems. However, the energy development situation may have added a new dimension to an old problem. From interviews with wildlife professionals, the consensus was that poaching in these areas may be higher than anticipated on the basis of increased population alone. The reasons given were varied. First, the type of individual employed, particularly in construction and especially in isolated camps, seems to be more likely to regard poaching as a victimless, minor offense of concern only to game wardens and of no real significance to wildlife populations in the area. Some regard the local hunting of big game as an unofficial job "bonus." Second, because of the location of their jobs, these individuals may have more opportunities to poach game. Third, as newcomers, they are less likely to have been exposed to the values practiced by local residents. Also, some individuals may use poaching to "prove" their stature among their peers. Finally, the social problems that sometimes accompany rapid growth, especially boredom and the lack of recreational outlets, may indirectly increase poaching.

The question of what methods can be used to project losses due to poaching was asked of several wildlife professionals. There was unanimous agreement that poaching in the vicinity of coal and oil shale operations and near growth centers is becoming more of a problem. There was almost unanimous agreement that a significant segment of the labor force, particularly the construction worker, is more skilled or more active in such activities than the labor force at large. For example, between 1972 and 1977, the population of Carbon and Emery Counties in Utah increased 37%. During the same period, a 235% increase in citations for wildlife violations occurred, and most involved violations that directly reduced wildlife populations (Nish, pers. comm.). There was no apparent source of data that would suggest participation rates for poaching. Similarly, there was widespread agreement that the number of incidents reported was only a very small fraction of the total problem, but sources of data suggesting this fraction were almost nonexistent.

PROFILE OF THE VIOLATOR

A rapidly expanding population does not necessarily lead to a poaching problem. Daneke (pers. comm.) found only 3.5 additional violations for each 1,000-person increase in a Colorado recreation boom area, while, in an adjacent mineral boom area, the rate of violation increased by twice that. Con-

sequently, a poaching problem cannot be predicted solely on population growth. Regional profiles do appear, however, to indicate areas with high violation rates, and by comparing social profiles for known violators with anticipated profiles for in-migrants, it is possible to evaluate the probability of a poaching problem.

Anticipated in-migration of people similar to those already associated with game law violations (hereafter referred to as potential violators) leads to a violation problem only when there is also an opportunity to poach. Thus, the impact area must also be evaluated in terms of a potential poaching problem.

The population segment most likely to be involved in a violation consists of men in the 20 to 39-year age class, with the 20 to 29-year age class predominating (Colorado Division of Wildlife, unpubl. data; Kaminsky and Giles 1974; Sawhill and Winkel 1974; Vilkitis 1968). Vilkitis found that violators usually rent their homes, are industrial workers who hold more than one job, and are unlikely to report strangers observed violating a game law.

Shafer et al. (1972) reported that deer poachers from New York State were relatively successful hunters, killing more deer legally per year than the average nonviolator. Fortunately, these poachers also tended to recognize areas where deer were overhunted, and Eye (1968) found that spotlighting declined as deer populations decreased.

Closed season violators usually hunted in groups (Kaminsky and Giles 1974), often with the same people they hunted with during the open season (Sawhill and Winkel 1974). Spotlighters were frequently found to be drinking or drunk while hunting (Kaminsky and Giles 1974; Sawhill and Winkel 1974).

Sawhill and Winkel (1974) also found that 41% of the New Jersey spotlighters they interviewed had never graduated from high school and that only 19% had any college education. They also discovered that all the violators in their study were still spotlighting deer. Apparently, apprehension about being caught did not deter offenders in this case. Thirty-five percent of the violators had been arrested previously for game violations, and 20% had a criminal record. Spotlighting was also a frequent activity; 35.1% were poaching with spotlights two to five times per year, and 54% were poaching with spotlights at least six times a year.

Spotlighting often occurs close to home; 59.4% of the violators from New Jersey were operating within 15 mi of their home (Sawhill and Winkel 1974). However, Kaminsky and Giles (1974) found that violators were usually unknown to the conservation officer. These researchers also determined that most spotlighting occurs along public roads (90%), but frequently involves trespassing on private land (52.9%).

Most deer poachers operate late at night (2100 to 0200 hours) during the fall and winter (Kaminsky and Giles 1974; Sawhill and Winkel 1974). Kaminsky and Giles (1974) reported that spotlighting declines when fishing season opens. Also, spotlighting occurs on Saturdays significantly more often, and on weekdays significantly less often, than expected by chance.

313

Reasons given for poaching big game usually include some tangible bene-
fit, such as food or profit (Kaminsky and Giles 1974; Sawhill and Winkel
1974; Shafer et al. 1972). Fabich (1980) reported values in excess of $1,000
for illegally caught big game animals. Other reasons for poaching included
opportunity, failure during the legal season, and "kicks." Chu (1980) be-
lieved that transients, particularly in areas with a high population turnover,
frequently will neither wait to establish residency nor pay high prices for
nonresident licenses. As a result, license violations are common in areas
with a large transient population.

Presumably, the results from big game poaching studies apply to other
poaching activities as well.

Morse (1971) categorized wildlife violations as accidental, opportu-
nistic, or premeditated. The previously cited research was concerned pri-
marily with premeditated violations, often the most difficult to apprehend.
The accidental violator includes the usually well-meaning hunter who inad-
vertently kills a misidentified species or sex or commits some similar un-
intentional violation. These violators are more frequently caught because
of lack of precautions combined with the normal conservation enforcement
activities during hunting and fishing seasons. Opportunistic violators are
often more difficult than accidental violators to apprehend because their
actions are largely unpredictable. However, the probability of an oppor-
tunistic violation varies with individual lifestyle and attitude. A rural
worker or resident who prefers to carry a firearm at all times seems more
prone to commit this type of violation than an urban worker or resident.

COOPERATORS

Cooperators (informers) are an important element in the control of il-
legal harvest. Forty-six percent of the successfully prosecuted closed sea-
son cases reported by 24 wildlife agencies involved cooperators (Beattie
1976). Enforcement problems may be self-mitigating if potential cooperators
comprise an important segment of the anticipated in-migration. Character-
istics of Mississippi cooperators included a tendency to hunt (82.3%) or to
associate with hunters (97.4%) and to own land (83.3%), with an average hold-
ing of 691 acres. In Beattie's study, all the hunters were Caucasian, 90%
were males, and their ages were broadly distributed. Most informers were
industrial workers living in the country on their own land and had annual
income levels of at least $14,000.

APPENDIX H.   SELECTED STUDIES OF DEER MORTALITY ON HIGHWAYS

There have been many studies on highway deer mortality. Reilly and Green (1974) found a peak and then a decline in highway mortality over a 13-yr study period on a new Michigan interstate highway. The study area was a 5-mi stretch of white-tailed deer wintering area in a district having 8 to 16 deer/mi^2. In the first year after highway construction, 41 deer were reported killed on the 5-mi stretch. Average daily traffic was 2,200 to 2,600 vehicles. Virtually all the deer fatalities occurred in the spring, a situation similar to that of a high density deer wintering area of Colorado where more than 75% of the highway mortality occurred in the first 4 mo of the year (Myers 1969). Reilly and Green (1974) hypothesized that the decline in annual highway mortality between the beginning and end of the study was the result of the early loss of: (1) a subpopulation of deer that the new highway had cut off from the main herd; and (2) individual animals that had formerly occupied the land taken up by the highway itself. This point is emphasized because highways can impact deer populations through both direct mortality and displacement of some individuals that become more vulnerable to road kills as they reestablish a home range.

Bellis and Graves (1971) studied an 8-mi section of Interstate 80 in Pennsylvania. There was a strong correlation between the number of white-tailed deer seen adjacent to the highway each month and the number killed (a 10:0.9 ratio). Highest mortality occurred in spring and fall. Mortality was highest where troughs had been formed by steep median strips or steep rights-of way, where troughs ended, and where both sides of the highway and the median strip provided good pasture. Total reported mortality for the 14-mo study was 286 deer along the 8 mi. It was pointed out that many road kills had probably gone unreported.

Carbaugh et al. (1975) also studied distribution and activity of white-tailed deer along Pennsylvania's Interstate 80, but looked at an agricultural area, as opposed to the heavily forested area examined by Bellis and Graves (1971). The length of highway studied was the same. Roughly one-seventh the number of deer were killed in the agricultural area as in the forested area, attributable to the fact that most of the deer in the forested section were grazing on the narrow rights-of-way, while nearly all deer in the agricultural section were grazing in the fields instead of on the rights-of-way.

Allen and McCullough (1976) reported that collisions between cars and white-tailed deer in southern Michigan peaked at sunrise and 2 hr after sunset. A low seasonal peak occurred in May, and a high seasonal peak occurred in November. The most common speeds at which deer-vehicle collisions took place were 50 to 59 mph, and deer were killed in 92% of the collisons.

Numerous other researchers also have studied the problem of deer-vehicle accidents (Puglisi et al. 1974; Reed et al. 1974; Arnold 1978; Pils and Martin 1979; Ward et al. 1979; Reed et al. 1982). Collisions not only have resulted in loss of wildlife, but have caused losses in human life, human injury, and vehicle damage. Data collected by Cathedral Bluffs Shale Oil Company in the Piceance Basin in Colorado indicate that periods of greatest road kill frequency for mule deer correspond to migration movement and use of roadside forage and hay meadows. This period extends from mid-October to late November and from early February to late April. Data for 1980 and 1981 indicate an average of 7.65 deer killed/10,000 vehicles on the Piceance Creek Road (Roberts, pers. comm.).

After a study of 812 highway crossings by mountain goats in Glacier National Park, Montana, Singer (1978) observed that successful crossings were highly dependent on slow vehicle speeds. When proposed highway reconstruction would allow an increase in average speeds up to 50 mph, an underpass was recommended to prevent road kills of mountain goats.

A State patrol officer monitored road kills of deer and elk from 1980 to 1982 in northwestern Colorado (Moffat, Routt, and Rio Blanco Counties). The officer estimated that reported road kills (accident reports to the State Patrol) were only about 10% of all road kills. For the three counties, there was an average of 147 reported deer kills/yr on about 300 mi of State highway. Assuming that reported kills equaled 10% of total kills, the average annual loss on State highways in the three-county area would be 1,470 deer. Special problem stretches, such as a 20-mi segment of Highway 13 in the Piceance Creek Basin, were thought to account for as much as 16% of the total loss in the three counties. Such areas can yield 1 to 2 reported kills/ day during periods of high deer activity.

A recent report of the Utah Division of Wildlife Resources (1981) estimated that reported road kills were about 50% of total road kills. Comparisons of road kills to harvest in 13 game management areas in 1979 and 1980 suggested that road kills equaled about 10% of the total harvest.

As pointed out by Streeter et al. (1979), road kills in energy development areas may be a special concern. Eyewitness reports of deliberate destruction of big game by haul truck operators were reportedly compiled by Colorado Division of Wildlife personnel. However, most road kills near mines occur by accident on access roads, particularly if these roads cross migration routes or if shift changes coincide with feeding periods.

316

APPENDIX I.   HABITAT ENHANCEMENT TO COMPENSATE FOR HABITAT LOSS,
DEGRADATION, OR ADVERSE HUMAN ACTIVITY IMPACTS

ENHANCEMENT OF TERRESTRIAL ECOSYSTEMS

Habitat establishment or enhancement are probably the most commonly
practiced programs for the mitigation of adverse impacts on wildlife. The
principal objective of wildlife habitat enhancement in a rapid growth area
usually is to increase wildlife diversity and productivity in areas per-
ipheral to the land use conversion areas, thereby increasing the carrying
capacity of the total area to approximately that which existed prior to in-
creased settlement.

An annotated bibliography of available technologies for fish and wild-
life reclamation, maintenance, or enhancement, with emphasis on Eastern min-
ing regions, was recently prepared (Herricks 1980). Included was literature
directed toward holistic approaches, site conditions that would support spe-
cific vegetative types, management of small impoundments, and wildlife man-
agement. Information is available about habitat requirements of key wildlife
species, as well as major land rehabilitation techniques successfully used
in Western area rehabilitation and reclamation projects (U.S. Fish and Wild-
life Service 1977, 1978a, 1978b).

Habitat establishment techniques range from single species seedings
for soil stabilization to sophisticated revegetation programs that include
shrub and tree transplants, elaborate seed mixes, and fertilization. The
objective of terrestrial habitat establishment or enhancement is to sustain
or increase the ability of a portion of land to support animal populations.
This may be for the wildlife population in general or for a particular target
species. In developing the habitat component of a mitigation program, the
specific habitat factors that are limiting to the populations of interest
need to be considered. Some actions will meet more than one objective.
For example, shrub and tree plantings at appropriate densities can improve
cover, and shrub and herbaceous plantings can improve forage availability.
Waterholes or guzzlers can be used to increase freestanding water for animal
use.

In undertaking mitigation programs, it must be realized that many com-
plicating factors may affect wildlife response to management practices.
Even the most promising programs may not produce the desired effect of in-
creased wildlife diversity and productivity. Seldom will a resource man-
ager know precisely what life requirements of a given species should be tar-
geted or exactly how a population will react to habitat manipulation. Con-
straints on time and money usually do not permit an intensive mitigation
program aimed at well-defined needs of particular species.

317

The following are some general guidelines for habitat manipulation planning. A variety of practices can be applied singly or in combination.

- Plant a variety of grasses, forbs, shrubs, and trees. This will enhance structural diversity. (Most animal species are more narrowly adapted to plant structure for thermal and hiding cover than they are to plant species for food.)

- Maximize edge and provide a patchy distribution of habitat types to meet a variety of niche requirements. By varying the size and providing a mosaic of habitat types, the number of animal species whose needs can be met is likely to be increased.

- Intersperse habitat types, waterholes, and other habitat factors near each other. This can fulfill the needs of animals with small home ranges.

Habitat enhancement techniques are often included in habitat establishment programs. Enhancement includes, but is not limited to, any of the following techniques:

- Brush piles, windrowed slash, deadfall, and large rocks or boulders can be selectively placed to increase wildlife cover. Small mammals, herpetofauna, cottontails, and songbirds will benefit most from this practice.

- Placement of nest boxes in wooded areas (both mountain and riparian woodland) will increase carrying capacities for tree squirrels, screech owls, woodpeckers, and songbirds.

- Placement of nesting structures and roosts in wet areas will increase waterfowl use.

- Water developments will increase the availability, quality, and presence of water throughout the year, resulting in increased wildlife use. Water developments may include development of ponds, seeps, natural springs, reservoirs, guzzlers, or wells.

In recent years, a number of structures have been developed as wildlife habitat enhancement features. The density of structures should be based on their proximity to other necessary habitat components (i.e., a lek in the absence of nesting habitat is useless). Examples of enhancement features are:

Raptor nest platforms and cliff cavities. Many species of raptors will use artificial nests when natural nest sites are limited or nests are accidentally destroyed. Use of artificial nest sites has been highly successful with ferruginous hawks, red-tailed hawks, ospreys, and great horned owls (Olendorff and Stoddard 1974; Call 1979; Olendorff et al. 1980). Golden eagles have been translocated successfully to artificial nests when mining activities began near their nest sites (Boyce et al. 1980). In this study, nests with chicks were moved to platforms progressively farther from

318

the original site, with the adults following and continuing to care for the young. Although limited experimentation has proven successful, individual eagles may respond very differently to disturbance and manipulations. Prairie falcon nest sites have been created by blasting or digging cavities into cliffs where natural ledges were lacking (Boyce et al. 1980). Use of the artificial ledges by prairie falcon ranged from 25 to 80% in different experiments.

Perch poles. Poles with horizontal crossarms are suitable perches for raptorial birds. Care should be taken in placing perch poles. Illegal shooting may result from raptors utilizing conspicuous perch areas. The raptors attracted to an area may prey on desirable animals, resulting in an additional management problem. Dead trees can also be placed upright to attract raptors and other nongame birds. Snags of this sort are particularly successful around lake margins.

Nest boxes. Simple to very elaborate nest boxes have been used to increase populations of cavity-nesting birds in areas where such nest sites are limited. However, nest boxes will probably need to be cleaned and repaired periodically. Designs for nest boxes for various species can be found in Yoakum et al. (1980).

Brush piles. Brush piles can provide animal cover and mammal den sites. They are built using woody vegetation large enough to persist for several years before decaying. This technique is particularly appropriate if small trees and large shrubs are removed to clear land for other purposes. Recommended dimensions of brush piles are 5 to 10 ft high and 10 to 20 ft in diameter.

Rockpiles. Rockpiles are built for shelter, mammal den sites, and raptor nest sites and perches. Recommended dimensions are 6 to 10 ft high and 15 to 30 ft long.

Courtship grounds. Where mining activities have threatened important sage grouse strutting grounds, attempts have been made to create alternate leks (Eng et al. 1979; Tate et al. 1979). The leks were created by making a clearing in sagebrush and using grouse decoys and recordings from leks to attract hens to the new leks. The long term success of the technique has not yet been established. Based on a study by Coal Creek Company in Campbell County, Wyoming, efforts to move sage grouse strutting activities to a totally new artificial lek site may be more difficult than moving a group of displaying birds to a location where a few birds have displayed occasionally (Tate et al. 1979). An experimental lek seemed to have been successfully established by the Decker Coal Company in Montana; sound may have played a lead role in recruiting birds (Eng et al. 1979).

Semiarid grasslands are characteristic of both the problem and the mitigation potential for wildlife in many energy development areas. A large percentage of Western grasslands have been grazed by livestock. If overgrazing occurs, it usually causes a shift in plant species composition away from the preferred forage species of both domestic animals and wildlife.

319

Many opportunities exist to enhance degraded rangelands for wildlife. If plantings are undertaken, plant species should be chosen on the basis of their use to the target animal populations, as based on four criteria: cover value; palatability; food value; and utilization. Equally important to the selection of plant species is adaptability to the local climate. Site characteristics to consider in developing plantings include: elevation; aspect; slope; seasonal temperatures; seasonal precipitation; soil (nutrients, texture, and moisture) microclimate; and animal needs. Plantings, especially trees and shrubs, on semiarid lands should be carefully planned due to the difficulty of establishing and maintaining vegetation on these lands.

In establishing plants, it is often desirable to use cultural practices that maximize initial growth, such as: (1) mulching for erosion control or to maintain moisture and organic matter; (2) herbicide application for control of weeds, noxious plants, and competitive species; (3) seedbed preparation by surface scarification or other suitable technique to reduce soil erosion, retain soil moisture, and modify soil density; (4) chaining to reduce vegetative competition; (5) fertilization to enhance soil nutrients; and (6) irrigation to enhance soil moisture for initial establishment of plants.

Many references on vegetation management, planting material suitability for various regions in the West, and planting equipment and seed stock are available (Plummer et al. 1968; Crofts and McKell 1977; Institute for Land Rehabilitation 1979; Blunt 1980). Additionally, the U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Soil Conservation Service, U.S. Bureau of Land Management, State game and fish agencies, and State extension services can provide information and guidelines for plantings.

The specific planting scheme should maximize structural diversity of the vegetative components of habitat. Placement of trees and shrubs to maximize cover and shade is a desired component of a habitat establishment or enhancement plan. The value of shrub plantings increases if they are placed in a patchy, irregular pattern, rather than in uniform rows.

Selective thinning of dense, homogeneous stands of sagebrush will release understory grasses and forbs from the competition of the dominant shrub stratum. A proliferation of grass and forb species will result over small areas, thereby increasing forage for livestock and providing a greater diversity in available habitat for wildlife. Raptors will benefit by being able to more effectively utilize the open areas as hunting grounds. Graminivorous and herbivorous small mammal and bird species will benefit from the increased food supply, while still enjoying the cover afforded by the nearby shrub stratum. Mule deer and white-tailed deer may take advantage of new green growth available on small, cleared areas during spring. Brush piles in cleared areas provide shelter for small mammal, reptile, amphibian, upland game bird, and songbird species. Boulders, rocks, and other natural structures capable of providing cover for wildlife should be left in areas cleared of shrubs. Key wildlife browsing and forage species should be planted in the small cleared areas within the sagebrush stands.

320

Livestock use of range areas utilized by big game species should be restricted until target carrying capacities are restored. Livestock may compete severely with pronghorn, mule deer, elk, and smaller primary consumers (e.g., ground squirrels, cottontails, jackrabbits, and prairie dogs) on range. Furthermore, ranges adjacent to a mining area could already be overcrowded with wildlife displaced from the disturbed site.

In summary, considerations for deciding on a vegetation manipulation plan for semiarid grasslands include the adaptiveness of plant species to site-specific conditions, cultural practices that may be necessary, and the value of plant species and structures in meeting animal needs for food and cover.

ENHANCEMENT OF AQUATIC, WETLAND, AND RIPARIAN ECOSYSTEMS

For the planner concerned with enhancing aquatic environments, an understanding of the terms used to differentiate between types of aquatic systems and the importance of these systems is necessary.

Briefly, aquatic ecosystems are open water systems that are permanently or intermittently inundated. There are two types of open water systems: riverine (streams and rivers) and lacustrine (ponds, lakes, and reservoirs). Wetland ecosystems are areas typically inundated or saturated by surface or ground water. Wetlands generally include swamps, marshes, bogs, and similar areas. In addition to specific plant populations and communities, wetlands are characterized by specific hydrological and physical characteristics. The riparian ecosystem has a high water table because of proximity to an aquatic ecosystem or subsurface water. Riparian ecosystems usually occur as an ecotone between aquatic and upland ecosystems, but have distinct vegetation and soil characteristics (Figure I-1). Aridity, topographic relief, and depositional soils strongly influence the extent of high water tables and the size of associated riparian ecosystems. In the West, these ecosystems are most commonly recognized by the presence of streambank vegetation.

Aquatic, wetland, and riparian ecosystems are essential to maintain a healthy natural environment. They provide: food chain production and habitat for aquatic and terrestrial wildlife; natural water purification; aquifer recharge; storage of storm and flood waters; shielding other areas from wave action, erosion, or storm damage; drainage, flushing, sediment, and salinity reduction; and environmental study, sanctuaries, and refuges.

Particularly in the Western United States, riparian habitats within the much drier surrounding area are disproportionately important for wildlife and multiple use activities. They are uniquely characterized by a combination of high productivity; high species diversity and density; and continuous interactions between riparian, aquatic, and upland ecosystems through exchanges of energy, nutrients, and species. Wildlife use riparian zones more than any other habitat type. Riparian areas vary considerably in size and vegetative complexity because of variations gradient, aspect, topography, soil, type of stream bottom, water quality, elevation, and natural plant community.
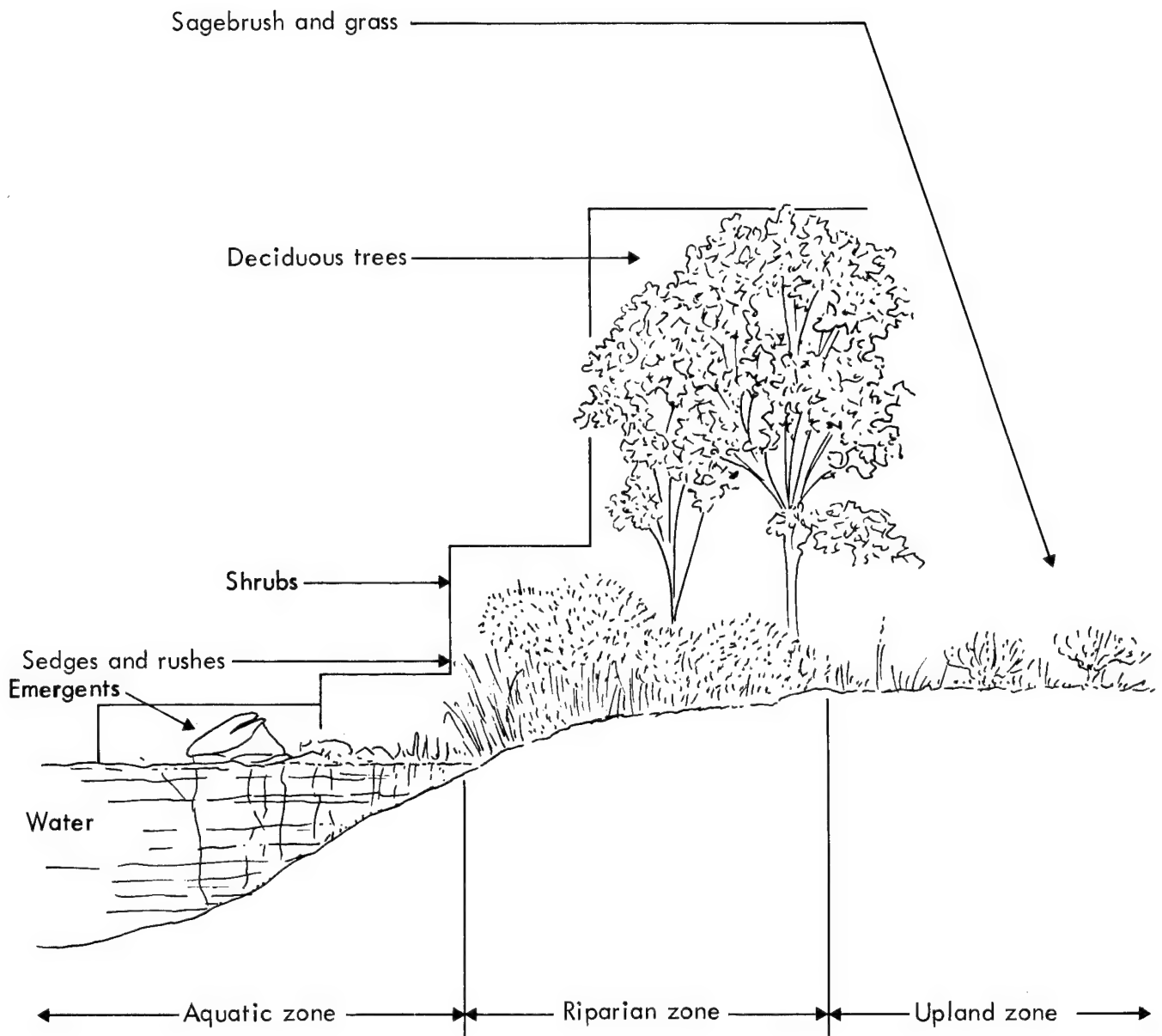
Sagebrush and grass

Deciduous trees

Shrubs

Sedges and rushes

Emergents

Water

Aquatic zone ——— Riparian zone ——— Upland zone ———

Figure I-1. Examples of aquatic, riparian (wetland), and upland ecosystems.

322

Many human uses are made of aquatic ecosystems, particularly riparian areas. Examples are livestock grazing, urban development, and recreation. With the exception of light recreation, such uses are almost always detrimental to fish and wildlife use of the same area. Limiting human uses to confined portions of riparian habitats can preserve the value of remaining areas. In many cases, enhancing existing lake and stream habitat or creating ponds and reservoirs is an effective means of increasing wildlife abundance and diversity. Additionally, properly designed aquatic, wetland, and riparian habitats are attractive landscape features.

Enhancement of Aquatic Ecosystems

Handbooks, such as the Western Reservoir and Stream Habitat Improvements Handbook (Nelson et al. 1978) provide guidance for selecting effective measures for habitat and population improvement on aquatic ecosystems. The success of approximately 286 improvement measures in 60 categories were investigated in preparing this handbook. The purpose, an illustration, limitations, performance, and cost for the 60 types of measures (Table I-1) are presented.

When changes in the flow regime are proposed where a high value fisheries habitat exists, computer simulation can be used to evaluate possible instream channel alterations in terms of changes in usable fish habitat area and potential changes in catchable fish (Wegner 1979). This information allows cost-effective analysis of various habitat improvement options.

Fish productivity is directly related to habitat quality, and waterflow is often a limiting factor in aquatic habitats in the West. Many streams are being dewatered for agricultural, industrial, municipal, and other purposes. Dewatering affects the quantity and quality of water, both of which affect aquatic life. The two primary nonstructural methods to ensure adequate quantities of water are minimum instream flow regulations and water rights purchases. Instream flow regulations maintain a specified minimum quantity of streamflow to protect the aquatic community structure and function, including fish and wildlife habitats. The purchase of water rights by natural resource agencies can be used to ensure adequate streamflows, but it may be at a high price [e.g., on Boulder Creek, Colorado, a 1 cfs (1.98 acre-feet) water right was purchased for $18,000 in 1977 (Nelson et al. 1978)].

Streamflow can also be altered structurally. Excavating a thalweg channel (deepest part of a low flow stream channel) over a relatively large area will reduce water surface area and allow greater depth with the same volume of water (Figure I-2). This essentially creates a stream within a stream, usually one with improved fish habitat because deep pools provide better cover. Thalweg excavation is generally performed with heavy equipment, though preferably with the smallest machinery suited to the task, at low flow, and as quickly as possible to minimize stream damage and adverse effects on water quality.

Table I-1. Habitat and population improvement measures
for Western reservoirs and stream habitats.

Habitat improvement measures	Population improvement measures
Reservoir flood basins	**General practices**
Selective clearing	Food and cover planting
Brush shelters	Browseway clearing
Tire shelters	Grazing control
Other fish shelters	Fish and waterfowl ponds
Exposed area planting	Wetland dredging and diking
Raised spillways	Macrophyte and algae control
	Settling and retention basins
Reservoir conservation pools	Land acquisition
Stage filling	Reservoir and flood plain zoning
Fluctuation control	
Seasonal manipulation	**Fish propagation**
Minimum pools	Fish hatcheries
Aeration--destratification	Nursery and rearing ponds
	Spawning bottom and marsh
Dam discharge systems	Spawning riffles
Low-level intakes	Artificial spawning channels
Multilevel intakes	
Spillway deflectors	**Fish passage**
Stilling basins	Trap and haul systems
	Fishways
Streamflows, riffles, and pools	Conduits and culverts
Minimum flows	Turbine bypasses
Fluctuation control	
Reregulating dams	**Fish stocking and control**
Maximum flows	Fish stocking
Current deflectors	Fish screens
Check dams	Barrier dams
Other instream devices	Other control devices
Artificial meanders	Fish eradication
Isolated oxbows	
	Wildlife propagation and control
Streamside protection	Nesting structures
Bank cover	Nesting islands
Bank stabilization	Passable fencing
Snag clearing	Guzzlers, waterholes, and springs
	Wildlife protection at canals
	Conduits and canal covers
	Impassable fencing
	Wildlife crossings
	Escape ramps
	Other protection

TOP VIEW

Thalweg
channel
& pool

Point
bar

Thalweg
channel

Point
bar

Thalweg
channel
& pool

Maximum flow channel

SIDE VIEW

100 year flood channel

Normal high
water level

Normal low
water level
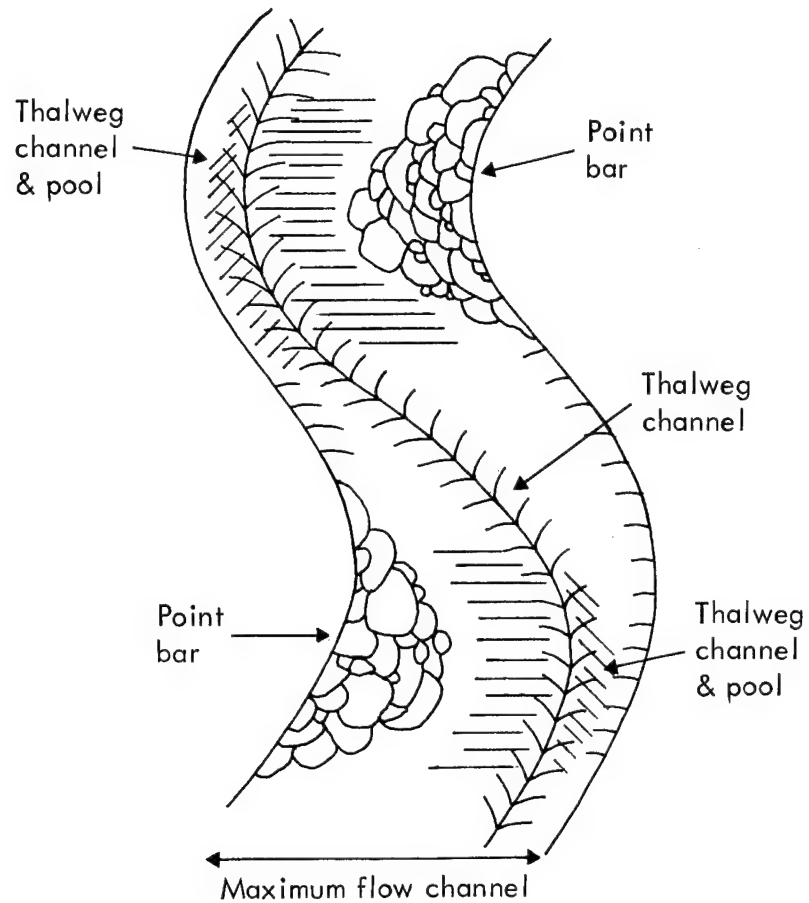
Thalweg
channel
& pool
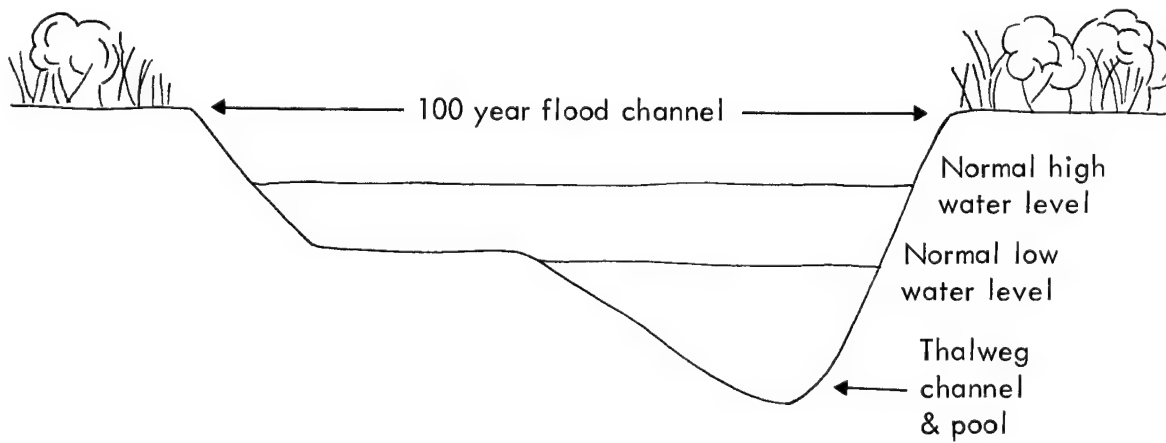
Figure I-2.   Typical thalweg (low-flow) channel configuration.

Very high discharge and velocity, beyond the limits of normal spring runoff, can adversely affect stream organisms. Flows in excess of runoff may be caused by transmountain diversions, dam releases, and irrigation diversions. These "super" flows can cause scouring; physically alter stream substrate; eliminate fish spawning, rearing, and nursery habitat; and remove fish food sources.

Platts (1979) has developed a numerical rating system for assessing stream environments. His criteria include bank type, cover, and pool diameter and width. Using Platts' criteria as guidelines, bank improvements, such as artificial undercuts can be evaluated. Should bank stabilization be a concern, enhancement techniques include riprap, gabions, and erosion control matting. Boulders, logs, and brush can be added to improve cover, but materials should be large enough to withstand spring runoff and a 100-year flood. (For example, if the stream bottom is stable, a 2-ft, 1,000-pound boulder will resist movement in current velocities of up to 10 ft/sec; a 4-foot boulder will withstand velocities up to 13 ft/sec) In general, large rocks are most effective where velocities exceed 2 to 3 ft/sec at medium flow. Barton and Cron (1979) suggest one boulder for every 300 ft^2 of channel. Logs and brush enhance riverine habitat and can be secured by cables or other means to withstand high flows.

Deflectors and dams can be used to create meanders, channel flow into a thalweg, create plunge pools, and catch sediments. Various designs and materials can be used. Instream dam types include rock, log, "V," and barrier dams (White and Brynildson 1967; Nelson et al. 1978). Barrier dams and fish screens can also be used to control fish movement and create impoundments.

Obstructions in rivers can interfere with the spawning run of migratory fish. If the obstruction is small, a fish ladder can be built to allow fish to pass (Figure I-3). If the obstruction is large or there is a large impoundment, large fish ladders and fishways have been implemented with varying degrees of success. In some instances, fish can be trapped and hauled around the impoundment (Nelson et al. 1978).

Some streams have inadequate area or bottom surface material for fish reproduction or spawning. Coldwater fish typically spawn in riffle areas. Riffles can be added to improve habitat (Nelson et al. 1978). Additionally, siltation, which degrades spawning areas, can be removed (Mih 1978; Nelson et al. 1978; Mih and Bailey 1979).

Streamside vegetation not only provides a source of insect food, cover for hiding, thermal protection, and resting, but also stabilizes streambanks and moderates summer water temperatures through shading. Overhanging streambanks provide important cover for fish in general and trout in particular. Streams channelized in the past for various reasons, such as flood control, can be reconstructed. Channelization removes stream meanders and creates a more homogeneous environment. Channelized streams, cleared of all debris, provide no habitat cover and are unproductive for aquatic organisms. Channel reconstruction can greatly increase fish carrying capacity.
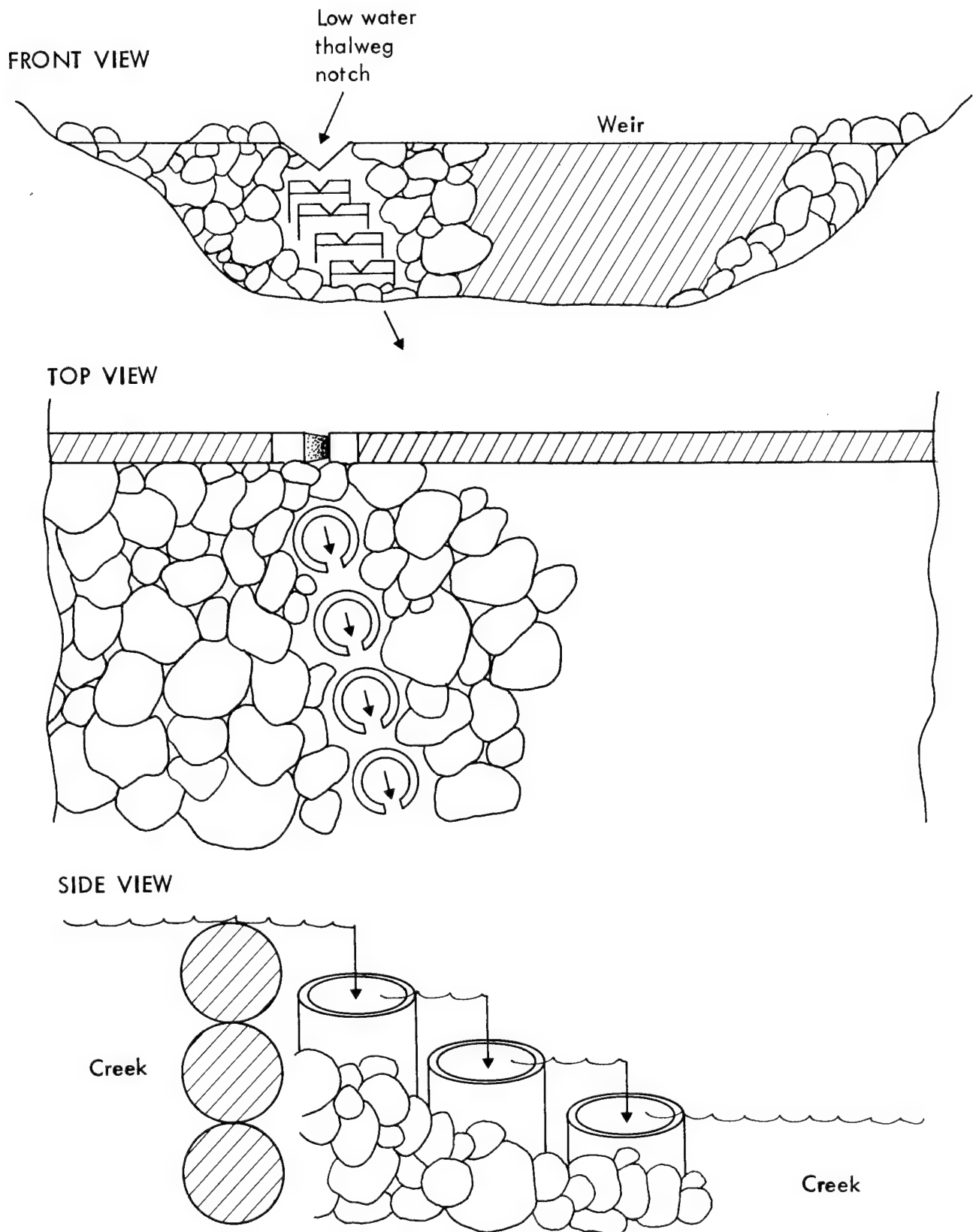
Figure I-3. Fish ladder composed of concrete cylinders 5 ft to 6 ft in diameter and 4 ft deep.

Habitat components to consider in reconstruction include bank and habitat cover, pools (deep water), and riffles (shallow water). These components should approximate natural conditions. In an undisturbed Western stream, the length of one pool and riffle sequence is generally equal to the sum of five to seven channel widths. Figure I-4 depicts a generalized pool-riffle configuration. The proportion of pool-to-riffle sequences within a given stretch is highly variable. Maximum diameter of a good quality pool exceeds the average stream width and the depth generally is over 3.3 ft, or over 2 ft with abundant fish cover (Platts 1979). As a general rule, water depth in a riffle area should be a minimum of 6 to 8 inches.

If a lake is built by damming a stream or river, a continuous release of water may be required. Instream flow releases may partially mitigate the adverse effects of damming the stream. However, the effects of these releases on downstream aquatic life can be quite pronounced. Two main problems are thermal changes and poorly oxygenated water. Large reservoirs may release water from the bottom of the dam, which is usually cooler during the summer and warmer during the winter, as well as less oxygenated, than the water below the dam. This contrast can create stress conditions for stream life. Temperature impacts can be modified by installing multilevel dam outlets. Deoxygenated water can be improved by releasing upper level waters (epi- and metalimnion), using spillway deflectors to oxygenate water prior to entry into the stream (Nelson et al. 1978), and using aerators in the stream at the base of the dam. Water quality, temperature, and flow below a hypolimnial release dam can also be designed to develop a cold tailwater sport fishery. Natural tailwater temperatures can be simulated by installation of "mixers" that permit the withdrawal of water from various levels in the water column.

Enhancement of ponds, lakes, and reservoirs to increase fish and wildlife carrying capacity can be achieved by improving either water quality or physical habitat characteristics. Nelson et al. (1978) have developed a manual for planning and management of mine-cut lakes that may be useful in enhancing lacustrine systems.

Water quality can often be improved to benefit aquatic life. In deep lakes, stratification can occur. This often results in a hypolimnion or bottom layer that has little or no oxygen. If brought to the surface, this water can be oxygenated. Aerators run by wind, electricity, or solar power and compressed air have been used for water circulation in lakes (King 1970; Toetz et al. 1972; Dunst 1974; Nelson et al. 1978). Other common water quality improvements involve turbidity, alkalinity, and pH modifications (Bardach et al. 1979).

Physical structures to improve cover, spawning areas, and streambanks can be quite varied. Tire or brush shelters can be used to improve cover (Nelson et al. 1978). Methods to improve or create spawning areas depend on reproductive characteristics of fish species present. For example, Webster and Eiriksdottir (1976) reported success using upwelling water to improve brook and rainbow trout spawning areas. A variety of materials can be used to create spawning areas. These include stake beds, gravel bottoms,

328

TOP VIEW

Thalweg pool

Thalweg channel

Point bar

Riffle

SIDE VIEW

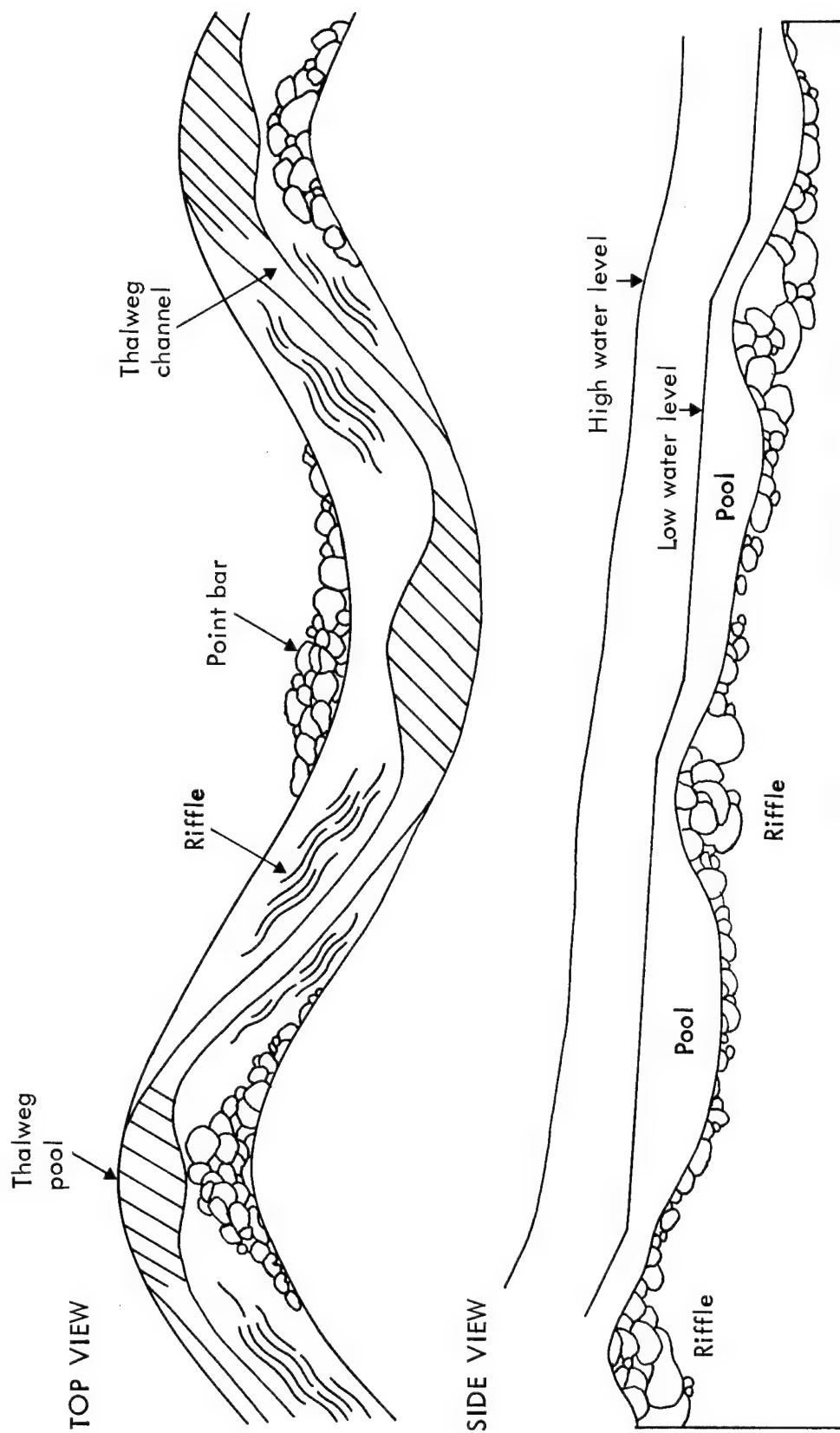High water level

Low water level

Pool

Pool

Riffle

Riffle

Figure I-4. Generalized pool-riffle configuration.

gently graded shallow water bottoms, milk cans, nail kegs, and earthenware crocks (Nelson et al. 1978; Bardach et al. 1979). Plantings can be used to improve streambanks. A 100-foot buffer zone with plantings that permit only low intensity activities near the lake helps deter erosion and pollution. Plantings provide both food and cover for animals and aesthetic appeal for people.

Of particular significance to terrestrial wildlife is the extent, quality, and physical configuration of vegetation along shorelines and on islands. A clumped pattern of trees, shrubs, and herbaceous vegetation is preferable to uniform plantings. Woody plantings should be appropriate to the region, but beneficial to wildlife. In the Northern Great Plains and Central Rocky Mountains, suitable species for areas of moderate soil moisture include wild plum (Prunus americana), hawthorn (Crataegus erythropoda), chokecherry (Prunus virginiana), skunkbrush sumac (Rhus trilobata), and serviceberry (Amelanchier spp.). Alder (Alnus tenuifolia), willow (Salix spp.), cottonwood (Populus spp.), and aspen (Populus tremuloides) do well on wet sites.

When beaver are present, cottonwood, aspen, and willow might require basal protection using screen-wire fencing. If beaver are numerous, these tree species might best be avoided entirely. Shrubby willow species that propagate quickly and withstand heavy foraging can be successfully planted as food for beaver. Normally, wildlife, other than beaver, are not damaging to riparian systems.

Shoreline design should include features that attract desired wildlife populations. Shorelines should contain coves, peninsulas, and shallow slopes (from 2 to 30% grades) in the original impoundment, lake, or island design. After a lake has been constructed, it is difficult to stabilize banks, soften steep grades, or add shoreline undulations.

Islands are important to wildlife for numerous reasons. The additional shoreline length provides increased food and edge habitats. Nongame bird and waterfowl nesting habitat is increased and there is greater protection from predators and from harassment by people and dogs. Islands also permit the development of mud bars, perches, and shallow water feeding areas in the lake itself. Small islands (as small as 3 ft in diameter) make attractive goose nesting islands. Most islands should be from 3 to 10 ft in diameter (but not necessarily circular) and should be placed in protected coves or on the upwind side of the lake. They should normally be about 2 to 3 ft above the water surface so that vegetation is in close proximity to the water table.

Enhancement of Wetland Ecosystems

Wetlands are areas of great natural productivity, hydrological utility, and environmental diversity. They store water, thereby controlling floods; improve water quality; recharge aquifers; provide habitat for fish and wildlife; and stabilize flow of streams and rivers. Wetlands also contribute to the production of agricultural products and timber and provide recreational, scientific, and aesthetic resources of National interest.

330

Wetlands are fragile and easily disturbed. A major goal in wetland conservation is to prohibit drainage, filling, dredging, and livestock use of these lands. Methods to control degradation include:

- develop paths around the periphery;

- use fencing, either passable, adjustable, or impassable, depending on management needs;

- build boardwalks for passage through wetter areas; and

- limit access during particularly sensitive times of the year.

If development is probable near a wetland, mitigation could include:

- establishment of a 100-foot buffer zone between the wetland edge and dry land;

- public acquisition for park, open space, or natural area;

- acquisition of a conservation easement on the land; and

- regulation prohibiting development closer than 100 ft from the edge of the wetland.

Enhancement of Riparian Ecosystems

Livestock are a frequent cause of significant damage to riparian, as well as to aquatic and wetland, ecosystems (Winegar 1977). As with wetlands, riparian ecosystems are a unique and limited resource and particularly fragile and easily damaged. Loss of vegetation by livestock grazing and trampling along streambanks can raise the water temperature, increase stream width, increase erosion and siltation, decrease water depth, and decrease streambank stability.

Suggested mitigation techniques for livestock damage include:

- Create a buffer zone surrounding the aquatic ecosystem. Desired limits of such a zone will vary by situation. Suggestions have been made for zones as small as 16.5 ft and as large as 100 ft (White and Brynildson 1967; Keller et al. 1979);

- Locate livestock water tanks or guzzlers at least 100 ft from streams;

- Fence all but a portion of a stream (leaving limited areas for cattle); and

- Build bridges across streams for animal or human use. Cattle guards can be included to control passage.

331

If wetland destruction is unavoidable, new wetlands can be established to replace the ones that are lost. It is recommended that between 1 and 10 acres of new wetland be created for each acre of wetland destroyed (Northwest Colorado Council of Governments 1981). The amount of new wetland needed to compensate for lost wetlands increases as a function of distance from the impacted wetland and the anticipated functional quality of the new wetland. The acquisition of the necessary land and water may be a difficult task. Once wetland hydrologic functions are restored, wetland vegetation can be established by transplants, seedlings, or seedings.

APPENDIX J. CONTROLLING ADVERSE IMPACTS OF REGIONAL DEVELOPMENT ON WATER RESOURCES

PROJECTING WATER USE FROM NEW DEVELOPMENT

Reservoir-streamflow simulation models developed for particular river basins and under assumptions of specific proposed reservoirs and water diversions can be applied to assess secondary impacts of regional growth. The models must be first calibrated for the river system of interest, using monthly flow data from established stream gauge stations. Assumptions on reservoir development should be made based on information from utilities, local and county engineers, industry representatives, and planners. Assumptions on operating schedules, including consumptive use, evaporation, and timing of releases, needs to be entered into the model and the resultant monthly outflows predicted. This output must be routed downstream through various gauging stations. Model outputs can be compared to existing flow conditions to determine the magnitude of flow volume change under the water use scenario.

The simulated streamflows become the input for calculations of corresponding fish habitat values. The latter will be one output of ongoing work of the Instream Flow and Aquatic Systems Group at the U.S. Fish and Wildlife Services Western Energy and Land Use Team in Ft. Collins, Colorado. The incremental methodology developed by the U.S. Fish and Wildlife Service is composed of four steps: (1) hydraulic simulation of a stream reach; (2) determination of the spatial distribution of combinations of depth, velocity, and substrate; (3) application of probability-of-use criteria for each species and life stage of concern; and (4) calculation of a "weighted usable area," by life stage of species, for each flow regime under investigation.

For energy impact areas in the Missouri River Basin, the Missouri Basin States Association (headquartered in Omaha, Nebraska) has a data base of water use for a 35-year period of record, 1944-1978. The data base quantifies 14 categories of water uses, including:

- number of energy sites;
- number of industrial sites;
- rural population (cities under 2,500 population);
- acres irrigated using ground water;
- acres fully and partially irrigated using surface water; and
- surface area of small reservoirs.

For each use category, the amount of water that has been depleted from the streamflow for that use is known. All 93 drainage basins of the Missouri River Basin (total 500,000 mi^2) are included in the data base.

Programs are available to look at any of the categories of water users in a graphic format. For example, rural population in a drainage basin can be graphed for the 35-year period. If projections of future population under assumptions of past trends are desired, the graphics package will also perform a trend analysis of the period or any part of the period of interest. The resulting trend line can be used to project use in a future period. Associated with the trend analysis is an equation of the trend line, enabling the user to project future depletions. Any water use category can be projected based on past trends. The future impact on streamflow can also be looked at based on projected new developments.

Using resource persons knowledgeable about the watershed area and each water user category of concern, it should be possible to develop 5- or 10-yr projections (e.g., future number of industrial sites and acres of irrigated land or surface area of small reservoirs) for each use category of interest. The associated streamflow depletions can then be estimated for each category. Alternatively, a trend analysis of some past time period for a drainage basin that has already experienced comparable energy-related urban growth, industrial development, and more intensive agricultural land use could be developed in order to project what might happen in a rural area about to have a significant increase in population growth and associated increased water use from many sources. Once future demands are projected and impacts to streamflow are calculated from these projections, resulting impacts on aquatic ecosystems can be predicted. The impact assessment would probably be based on estimated instream flow requirements.

PROTECTING INSTREAM FLOWS

It is important that resource managers try to make community leaders aware of potential conflicts between urban development and instream flow requirements. Allocating water rights without considering future instream flow needs could result in severe ecological stress, often on threatened or endangered species, and perhaps lengthy litigation. Reservoir projects may accompany regional development; such projects should be assessed very early to determine the potential for supplying local water demands while maintaining instream flow requirements. Problems can be compounded by irrigation demands, because agriculture in some areas is a much greater user of water than most municipalities.

Instream flow requirements should be established where human activities could significantly deplete natural runoff. To protect the aquatic environment, the amount of surface water available for diversion to agricultural, municipal, and other non-energy facility uses can be limited by regulations that require maintenance of specified flow levels.

Various methodologies have been formulated for establishing instream flow requirements and predicting impacts on aquatic communities (U.S. Fish and Wildlife Service 1976, 1978). Some employ dissolved oxygen as the guiding parameter; some use a particular fish species; and others consider insect productivity in setting the criteria. Designated minimum flow levels may need to be different at different points on the same river or change during the year.

While the methodology and capability exist to identify and quantify instream values, conflicts can arise in the political arena. The legal basis on which instream values can be preserved is a paramount factor in determining whether or not instream flow objectives can be met. Preserving instream values reflects changing social values; historic water use patterns in the West did not generally include the preservation of instream values. Western water law is generally based on the appropriation doctrine, where a direct flow diversion must be put to a beneficial use, which is the measure of allowable use. Within this context, preserving instream values is an anomaly. Many States have moved to incorporate instream values in legislative enactments, but, even in these States, existing water right holders must be protected.

In some States, the status of instream values is unclear. For example, in Wyoming unlike most of other Western States, no legislation expressly recognizes the beneficial use of water to preserve instream values. There have been concentrated efforts in Wyoming over the last 2 years to legislatively recognize instream values. This effort has failed on two occasions because many individuals believe that: (1) instream flows should be tied strictly to storage; and (2) it is difficult to handle instream flows administratively without incurring injury to water right holders. In Wyoming, especially where major energy development is occurring, streams are generally fully appropriated, which presents a major hurdle for preserving instream flows unless storage is provided (Reese, pers. comm.).

An investigative study of potential strategies for preserving instream flows has been conducted on a state-by-state basis. Summary reports are available from the U.S. Fish and Wildlife Service, Western Energy and Land Use Team, Ft. Collins, CO. An evaluation of five instream flow methodologies for fisheries in Nebraska looked at the question of choice of method for resolving instream flow issues through negotiation and for resolving issues involving valuable fishery resources (Hilgert 1982).

Four strategies for reserving instream flows indicated by Solomon and Horak (1979) to be the most effective (in recognition of existing institutional constraints) include: (1) State appropriation of instream flows; (2) State discretionary water permit authority; (3) Federal license and permit stipulations; and (4) State and Federal flow requests that are made early.

State Appropriation of Instream Flow

Where available (e.g., Colorado), State appropriation of instream flow gives the State legal standing for ensuring that its water claim will benefit fish and wildlife. The major weakness of this strategy involves the difficulties in defending it against legal challenges contesting that the quantity of streamflow appropriated is in excess of the amount necessary to meet fish and wildlife needs. Refinements in instream flow methodologies can be expected to strengthen the State's defense against legal challenges. Costs needed to quantify instream flows generally are substantial. Potential benefits and costs of such efforts are usually weighed against other program activities of State or local interest.

State Discretionary Water Permit Authority

This strategy is available to most Western States. In this strategy, the State fish and game agency or a private group can petition or recommend to the State water rights administrator that: (1) applications filed for new, exchanged, or transferred water rights be denied or modified when they jeopardize existing appropriations/reservations granted for the benefit of fish and wildlife; or (2) new permits be modified or denied as a matter of the public interest. Each State has a statutory clause that empowers the water rights administrator to deny permit applications that are contrary to the public interest.

Federal License and Permit Stipulations

In the process of issuing permits and licenses for resource development, Federal agencies, such as the Bureau of Land Management and the Forest Service, allow fish and wildlife interests an opportunity to recommend instream flows.

State and Federal Flow Requests Made Early

This strategy has received the widest use among Western States. State and Federal fish and wildlife agencies need to be involved in the earliest stages of project planning.

Successful "negotiation" of instream flow requirements where impoundments are proposed may require resource managers to adopt a process-oriented view, which could include the following steps (Anderson 1982):

1. Define preproject and postproject flow conditions with computer analyses. Simulate wet, dry, and average years; then determine maximum stage changes by month and year. Compare these with stage changes from day-to-day flow variations. Compare flows with and without the projected additional water diversion, use, or storage. The timing and magnitude of instantaneous flows are very important to consider.

2. Determine how much instream flow would be needed to provide specified levels of aquatic ecosystem maintenance.

3. Where endangered species are present, distinguish between flows that would appreciably reduce: (1) the likelihood of their survival; and (2) the likelihood of their recovery.

4. Identify the water rights that would be affected for each period of the year if instream flows were maintained at the level required for stream maintenance, and estimate the economic effects on water right holders of reserving the instream flow.

5. Seek support for instream flow maintenance where values from maintenance are high enough to offset losses in production by those farms or businesses that would receive less water.

6.   If necessary, enter the market reallocation process through the purchase or proposed condemnation of water rights.

7.   Where all other efforts fail, seek water transport from storage in upper reaches downstream for use or storage in lower reaches to maintain levels of flow.

PROTECTING WATER RESOURCES FROM ADVERSE IMPACTS OF URBAN GROWTH

Streams in or near developing areas are susceptible to adverse impacts from many sources. Four approaches to mitigating these impacts are described below.

Control of Erosion During Construction

City or county building permits can be contingent on use of erosion/ sedimentation control measures by developers. These measures need to deal with hydrographic modification (increased runoff) caused by construction activity, as well as with soil loss per se.

Control of the Location, Design, and Operation of On-Site Sewage Disposal Systems

On-site waste disposal systems, particularly domestic systems, can constitute a very serious water quality problem in many areas. Controls should include the following: (1) prevention of new on-site disposal systems in areas where soil characteristics, land slope, or proximity to receiving waters will preclude satisfactory operation; (2) design of new systems in order to ensure adequate performance under the given land conditions; and (3) maintenance of performance standards for septic system operation. Prohibitive soil characteristics for new on-site systems could include overly rapid percolation, which would result in ground water pollution, as well as overly slow percolation. Maintenance of performance standards requires monitoring of present practices.

Construction of Leakproof, Accessible Sanitary Sewers

Sanitary sewer leakage and bypasses can contribute significantly to water problems in many areas. In the construction of new systems, best available technology should be utilized wherever possible. For some types of development, the most cost-effective strategy for water quality control could conceivably involve combined sewers, but separate storm and sanitary sewers will be assumed here. An important objective in such cases is to keep the systems as separate as possible. Roof drains, foundation drains, and other sources of water for which treatment is unnecessary should not be connected to sanitary sewers because this increases waste treatment costs and may lead to overload of the system and need for bypasses. Conversely, new development should be designed to discourage the use of storm sewers for disposal of wastes requiring treatment. Finally, an important objective is to design new development in such a way that sanitary sewers are readily accessible for repairs. A favorable design may involve location of sewers beneath sidewalks or grass strips bordering the roadway, rather than under the roadway itself.

337

Control of Hydrographic Modification

The control of hydrographic modification (increased runoff) due to urban development involves: (1) prevention of an increase in peak discharge; (2) prevention of a decrease in base flow rates of aquifer recharge; and (3) protection of watercourses from encroachment and alteration. Controls dealing with hydrographic modification should be designed to maintain existing conditions as closely as possible; zero impact is in most cases a feasible goal. With regard to the first two objectives, the most cost-effective design for a given development project is likely to involve a combination of control measures. Runoff detention devices are generally needed to prevent an increase in peak discharge, whereas base flow maintenance and aquifer recharge may require infiltration devices (with careful attention paid to possible ground water pollution due to these devices). Overall modifications of development design, such as restriction of impervious coverage, can be extremely useful, but rarely are sufficient by themselves to attain zero impact.

A critical aspect of focusing on hydrographic modification is that the controls utilized will have very substantial water quality benefits. Temporary storage of storm runoff in detention basins brings about significant reductions in most pollutant loadings due to the settling out of particulate materials. Infiltration devices tend to achieve much greater pollutant reductions. For most types of new urban development, the decrease in pollutant loadings achieved by control of hydrographic modification is likely to be sufficient for water quality protection, assuming that other measures, as specified below, are also implemented.

Protection of stream channels and other water bodies from direct physical alteration is considered an important element of the approach suggested here. The objectives include not only preservation of aquatic habitats and retention of the natural capacity of stream channels to dissipate flooding effects (i.e., to reduce flooding downstream through temporary storage of storm waters), but also protection of the role of headwater stream channels as "sinks" for sediment and other pollutants. This role of stream channels may be very significant. Although accumulations of pollutants are generally undesirable at any location, it is probably better for such materials to be deposited in headwater alluvial sediments than to affect ambient water quality at downstream points where water use is generally heaviest. An important point is that efforts in this regard should be coordinated, where possible, with ongoing or prospective flood plain management programs.

Mitigative measures can be utilized at almost any buildable site. The direct and indirect costs of implementing these measures, which are usually borne by private builders, tend to be small relative to total project cost. Thus, prevention of hydrographic modification will not prohibit most types of development at most locations.

Adequate control of impacts on the water quality from land development will require at least three additional classes of actions: (1) "housekeeping" measures, such as routine cleaning of streets, parking lots, catch basins, and other areas where pollutants accumulate; (2) public information programs to create awareness of water quality problems and their causes; and (3) actions to prevent the occurrence of site-specific pollutant sources. The last element could include monitoring of a wide variety of waste management practices and facilities.

338

APPENDIX K. INSTRUCTIONS FOR THE USE OF A CONTINGENT VALUATION METHOD

THE CONCEPT

Maximum willingness to pay (WTP) is the conceptually correct measure of the value an individual places on the opportunity to obtain a preferred bundle of goods. Similarly, minimum willingness to accept (WTA) a payment correctly measures the individual's valuation of the opportunity to relinquish a bundle of desired goods. WTP and WTA are general concepts, valid in market and nonmarket situations. In trading situations, they are identical to a buyer's best offer and a seller's reservation price, respectively. In the special case of small changes in the amount of a good traded in large and competitive markets, WTP/unit = WTA/unit, and both are equal to unit price. For larger quantity changes, ordinary consumers' surplus (the area under the demand curve and bounded by the "with project" and "without project" quantities) is often a reasonable approximation of WTP or WTA (Brookshire et al. 1980). Only when the good or amenity involved is very important to the user, as may be indicated by the good or amenity taking a large share of the total budget and having a high income elasticity of demand, or total value, as the case may be, is the difference between WTP and WTA empirically important. In these cases, WTA exceeds WTP, sometimes significantly (Randall and Stoll 1980).

Because WTP and WTA are approximately equal in many typical cases, and there are concerns about the accuracy of survey measurements of WTA (Bishop and Heberlein 1979; Meyer 1979), it has become customary to measure WTP for changes to both preferred and less-preferred bundles of goods (U.S. Water Resources Council 1979). For less-preferred bundles, the WTP measure is "WTP to avoid a change to a less-preferred bundle." The caveats implicit in the preceding paragraph remain valid, however.

It is important to carefully define the good being offered. If, for example, the good is "the right to buy a hunting license under the customary conditions," WTP for that right is equal to the consumer's surplus for the hunting season. Total value of that right to the consumer is equal to WTP plus the dollar amounts of any fees (e.g., license fees and access fees) paid specifically for the privilege of hunting. The value of a population of game animals is different again. It includes the value of the right to hunt and to observe, plus any option and existence values, all for that particular population. Increments or decrements in population size are handled similarly. The analysis is always in a "with project" versus "without project" context.

The above discussion refers to individual valuations. In estimating dollar values for wildlife resources, individual valuations are aggregated across the population of people who use or enjoy the resource of interest.

CONTINGENT VALUATION METHODS

The WTP concept is an entirely general basis for economic valuation. Contingent valuation methods represent one category of methods available for estimating WTP in the absence of direct markets. (The other major category is the expenditure function methods, which include the travel cost method.) Contingent valuation methods attempt to design and use hypothetical markets that can be used to identify the value of goods and amenities, just as would actual markets, if they existed.

Contingent valuation methods involve three basic steps: (1) the analyst establishes a hypothetical market, in detail: (2) the analyst communicates that hypothetical market to the respondent and permits the respondent to "use" the hypothetical market to make "trades" and establish prices or values that reflect the respondent's individual valuation of the goods, services, and amenities "bought" or "sold"; and (3) the analyst treats the values reported by the respondent as individual values for the goods, contingent on the existence of the hypothetical market. The analyst uses these values, along with the data contained in the market description, as basic data for estimating the aggregate value of the goods, services, and amenities.

The advantages of contingent valuation methods are their broad range of application and simplicity of analysis. Whereas the range of permissible applications of methods like travel cost is limited by several considerations, contingent valuation can be applied wherever a plausible hypothetical market can be designed. Applications to use values for amenities beyond the existing range of quantities and qualities and to nonuse values (such as option and existence values) are permissible. The theoretical basis of contingent valuation is also straightforward and consistent with the WTP concept of value. The disadvantages of contingent valuation methods stem from the contingent nature of the exercise and the survey method of data collection.

Because hypothetical markets are used, respondents may underinvest in decisionmaking. This could introduce random error into the value data collected. Further, respondents unaccustomed to paying for the use of wildlife amenities may state a lower maximum WTP than they would actually offer if confronted with a real market and given adequate time to react to it. This, if it occurred, would bias the results downward.

Given the relatively weak incentives to reveal true valuations, some respondents may seek to bias the results of the exercise toward the outcome they personally prefer. It is easy to construct theoretical situations in which this kind of strategic behavior could occur, but, in spite of considerable efforts to identify cases of such behavior, there is little empirical evidence that it is prevalent.

Given that surveys are used to collect value data, the various problems inherent in survey design and administration are relevant. Efforts must be made to avoid error or bias in sampling and communication between survey designer and respondent (often with an interviewer as intermediary).

Finally, it should be noted that a considerable body of published research is now available comparing the empirical results of contingent valuation and various expenditure function methods, including travel cost (see, for example, Bishop and Heberlein 1979; Brookshire et al. 1982). Results show considerable consistency across the different methods. If anything, the evidence suggests that contingent valuation methods might underestimate WTP.

CONTINGENT VALUATION SURVEY METHODS

Steps common to all applications are described below.

Step 1 - Describe Increment or Decrement in Fish and Wildlife Resources

This may involve describing with project and without project conditions, drawing attention to the differences. Description should include quantity, quality, time, and location dimensions, as relevant.

Step 2 - Construct and Describe Hypothetical Market

What rules apply to this market? How is payment to be (hypothetically) made? Descriptions ought to be sufficiently complete that each respondent perceives the market in the same way. However, too much market information may cause confusion. The construction of the market should be plausible (to minimize the perception that the whole exercise is meaningless) and designed to discourage strategic behavior.

Step 3 - Construct WTP Question

Several options are described below.

Form (a) - Iterative bidding. A dollar amount is stated and the respondent answers yes and no to a question asking would he/she pay that amount for the increment in the good, under the stated market conditions. Depending on the answer given, the amount is varied upward or downward until the highest amount eliciting a yes answer is identified. This amount is maximum WTP.

Form (b) - One-shot question (closed-ended). A dollar amount is stated and a yes or no answer is called for. To permit analysis, the sample is subdivided randomly, and each subsample receives a questionnaire stating a different dollar amount. Because the answer usually does not identify the respondent's maximum WTP, the analysis for this question format differs from that for all other formats. Typically, a logit analysis is required.

Form (c) - One-shot question (open-ended). The respondent is asked to state maximum WTP for the increment in the good.

Form (d) - Two questions. A one-shot closed-ended question is followed by an open-ended question. This format may have some advantages.

341

While less time-consuming than iterative bidding, it may be almost as effective in communicating the marketlike concept of WTP. It also permits two different analyses of WTP, a logit analysis based on the first question and a regular aggregate WTP analysis based on the second.

Step 4 - Explore the Reasons for Zero WTP Bids

Respondents may bid zero if the increment is worth nothing to them ("true zero" bid) or if something about the contingent market offends them ("protest" zero bid). Zero bids must be followed up with questions to sort true zero bids from "protest" bids. The latter are recorded and provide one indication of the effectiveness of the contingent market. However, they are not included in the analysis to estimate aggregate WTP.

Step 5 - Collect Demographic and Other Relevant Data

These data are needed to permit: (1) attempts to statistically explain individual variations in WTP; and (2) extrapolation of results to populations other than that sampled.

SURVEYS

Personal Interview Surveys

Personal interview surveys have considerable advantages. First, they allow use of relatively long survey forms, which permits gathering of value data for several different changes in amenity levels in one interview. Second, they permit the use of any of the various WTP question formats. (Iterative bidding, form (a), which many researchers prefer, is not amenable to mail surveys.) Third, they allow the use of a wide range of verbal and nonverbal stimuli to communicate the nature of the good and the hypothetical market rules to respondents. Nonverbal stimuli may include photographs, charts, and recorded sounds. Finally, they facilitate comprehension, cooperation, and high response rates by permitting interaction between respondent and interviewer. The disadvantages are that personal interviews are expensive to conduct and possible interviewer bias must be considered.

Mail Surveys

Mail surveys are relatively inexpensive and avoid interviewer bias. However, they impose certain limitations on the survey. First, survey forms need to be brief to ensure reasonable response rates. This limits the number of distinct changes in amenity level that can be valued, the use of supporting materials to describe the good and the hypothetical market rules, and the amount of demographic and other supporting data that can be collected. Second, WTP question formats are limited to one-shot questions and two questions [forms (b), (c), and (d)]. Third, stimuli are limited to information that can be transmitted on the printed page (words, photographs, tables, charts, and diagrams). Finally, survey forms need to be designed with great care and thoroughly pretested in order to avoid confusion and misinterpretations.

In spite of these limitations, the research literature includes an increasing number of successful applications of mail surveys. With careful attention to survey design and followup communications with slow or reluctant respondents, adequate response rates can be achieved.

Sample Size

Individual household WTP tends to have a relatively high variance. Its distribution is usually truncated at zero (negative WTP for an increased amenity level is not permitted) and may be truncated at some upper level (by a decision on the part of the research team leadership). The distribution may be truncated normal or skewed.

For these reasons, accurate WTP estimates require reasonably large sample sizes. Research expense, of course, varies directly with sample size. This provides an obvious incentive to keep sample size fairly small.

Desirable sample sizes are at least 200 for personal interviews and at least 600 for a mail survey. If the research budget only permits very small samples, serious consideration should be given to abandoning the contingent valuation method in favor of the modified UDV method.

Selection of Sample

All the basics of survey sampling methods are relevant and should be observed. In addition, there are some specific considerations that need to be addressed in sampling for WTP surveys.

First, the unit for sampling should be the individual license holder or permittee for those hunting and fishing activities subject to license or permit. Aggregation should be across the relevant regional population of license or permit holders. For other hunting and fishing activity values, observer values, or option and existence values, the appropriate unit for sampling is the household. WTP should be obtained on a household basis, and aggregation should be across the relevant regional population of households.

Second, if it is planned to intensively sample one local population and apply the results to other populations, it is necessary to obtain good estimates of the relationship of WTP to various demographic variables. For this purpose, a stratified random sampling procedure, sampling more intensively those with demographic characteristics less common in the local population, may be preferred to a standard random sample.

The third consideration is that, for personal interviews, a randomized cluster sampling scheme will reduce survey expenses without major losses in reliability of results.

Normally, the local or regional population to be impacted by the proposed project would be sampled along with the population of visiting amenity users (if that population is expected to account for a significant proportion of aggregate value). The increment in the good asserted in the survey should correspond with that envisaged in the proposed project. There is, however, one very important exception to these procedures. When the proposed project

is well-known and controversial among the local population, overtly asking a sample of local people about their WTP for increments or decrements in amenity levels that would result from implementing that project may well increase the occurrence of strategic responses. Project supporters may overstate WTP for its beneficial effects and understate WTP to avoid its adverse effects in order to improve the project's chances of implementation. Project opponents may behave in the opposite fashion. To minimize the occurrence of strategic responses, it is advisable to sample some different (but otherwise similar) population away from the project impact area and to describe the contingent market in such a way that most respondents would not recognize the particular project at issue. With appropriate analysis of the relationship of WTP to various demographic variables, the results of such a survey can be used to estimate aggregate WTP for the impacted population.

WTP FORMATS FOR SPECIFIC VALUATION TASKS

Tasks discussed include hunting values, nonconsumptive use values, option prices, and existence values.

Hunting Values by Species

The increment or decrement. For the impacted area, define the without project conditions in terms of game populations, scenic and associated amenities, and other similar characteristics. Define with project conditions in similar terms. Identify the increment or decrement involved. If several species are affected, questions need to be designed and sampling plans developed for each species. If the population of licensed hunters is the same for each species, each species can be handled in sequence with the same population of respondents. If not, separate surveys may be needed for each species.

Express the increment or decrement in terms meaningful to the hunter. For example, project evaluations might conceptualize impacts in terms of a decrease in population of a herd. However, if that decrease can be represented in terms of the frequency with which a hunter might expect to encounter a game animal during a day in the field, it can be made more meaningful to the individual respondent.

There are several options for defining the unit to be valued. These are the hunter day, the animal bagged, and the annual value of the right to hunt under the stated conditions. For most purposes, this last-mentioned unit of value (the annual right to hunt) is preferred. This number can be converted to use-days based on actual records of hunter days per licensee.

The contingent market rules. Basically, the contingent market rules for hunting values assert that the respondent must choose between a reference situation for which they would not be expected to pay extra and an alternative situation that can be obtained for an extra payment. For increments in hunting amenities, the reference situation is the current situation and license and access fees; the alternative is the "with project" amenity level

344

offered for an additional fee. For decrements, the reference situation is the "with project" level at the current fee; the alternative is the (preferred) "without project" level of amenities, which could be retained only if an additional fee is paid. Because the payment vehicle is a license or access fee, there is no problem with exclusion; those who do not pay get only the reference situation, which, in each case, is the less-preferred level of amenity.

The WTP question. If a personal interview survey is used, iterative bidding or two questions are preferred. If a mail survey is used, two questions are preferred. Express the question in the "take it or leave it" atmosphere of the marketplace. Avoid wordings such as, "Would you be willing to pay $_____?," which sounds like an appeal to philanthropic instincts (or a request for donations).

Sample wordings for each format are as follows.

Form (a) (for an increment). The respondent is asked if (the preferred situation) could be obtained for an additional fee of $X: "Would you take it, or would you refuse to pay the additional fee and thus retain (the less-preferred situation)?"

Yes (take it) _____ No (refuse) _____

If yes, raise the stated additional fee and repeat the question. If no, lower the stated additional fee and repeat the question. Continue the process until the maximum acceptable additional fee is identified.

Final bid (maximum WTP) $_____

Form (a) (for a decrement). After explaining that a course of events has started which, if nothing is done to stop it, will diminish hunting opportunities, the respondent is asked, "If you could retain (the present, and preferred, situation) by paying an additional fee of $X, would you do that, or would you refuse to pay the additional fee and thus permit hunting conditions to decline to (the with project, and less-preferred, situation)?"

Yes (pay) _____ No (refuse) _____

If yes, raise the stated additional fee and repeat the question. If no, lower the stated additional fee and repeat the question. Continue the process until the maximum acceptable additional fee is identified.

Final bid (maximum WTP) $_____

Form (d) (for an increment). Question one: "If (the preferred situation) could be obtained for an additional fee of $X, would you take it, or would you refuse to pay the additional fee and thus retain (the less-preferred situation)?"

Yes (take it) _____ No (refuse) _____

Question two: "Then what is the very largest additional _____ fee you would pay rather than go without (the preferred situation)?"

Final bid (maximum WTP) $_____ .

For only those respondents whose final bid was $0. "Did you refuse to
pay an additional ____ fee to get (the preferred situation) because (check
one)

  1. The opportunity to get (the preferred situation) is worth nothing
      to you?"

  2. You do not think it is right that hunters should be expected to
      pay extra just to get (the preferred situation)?"

  3. For some reason, you just can't take this kind of question seri-
      ously?"

For analysis, response (1) is considered a true zero bid and included
in all analyses. Responses (2) and (3) are considered protest bids and
tabulated but not included in calculation of sample mean WTP. During pre-
testing, formats that generate more than 15% protest bids are candidates
for elimination from the final survey form.

Note: When considering other valuation tasks, all of the above steps
are relevant. Because many of procedures can be readily adapted to differ-
ent valuation tasks, the discussion immediately below concentrates on major
divergences from the procedures for obtaining hunting values by species.

Nonconsumptive Use Values

"Nonconsumptive" means that use does not eliminate the particular speci-
men used. Further, nonconsumptive use values must be distinguished from
option and existence values, which do not depend on current use. These con-
siderations suggest that wildlife observation and the contributions made by
the presence of wildlife to enjoyment of nonhunting recreation experiences
must be the major categories of nonconsumptive use value. For compactness,
these are called the "observation value."

Observation value may be associated with a wide range of species, con-
siderably more than just game species. Satisfaction may be derived from
sighting particularly rare or spectacular species or from observing the
interrelationships among species ("the harmony of nature"). Different ob-
servers may focus on different aspects of the observation experience. Thus,
defining the "good" of interest and the increment or decrement to be valued
requires considerable thought. If, for example, the with project ecosystem
is expected to be generally impoverished (some attractive species eliminated,
others in reduced numbers; some less desirable species increased in number
and range), it may take substantial effort to communicate to respondents
the nature of the decrement. Charts, diagrams, and pictures may help.

A second problem concerns exclusion. Licenses and permits for observers
are not customary. Access fees to areas that offer good conditions for wild-
life observation are more common but by no means universal. Problems may
arise if access fees are used as the payment vehicle in contexts where such

346

fees are not customary; some respondents may resent the notion of access fees, resulting in increased incidence of protest bids.

If access fees are plausible and cause no apparent problems in terms of protests, such fees should be used as the payment vehicle. If access fees cause problems, the alternative payment vehicle is a trust fund to be used to maintain wildlife populations for observation. Sample wording for a WTP question based on payments into a trust fund, for a decrement, is as follows.

> "Unless households in (the affected region) pay into a trust fund to be used entirely to maintain wildlife populations and habitat, conditions will deteriorate to (the less-preferred situation). Your household would be expected to pay $X annually into the trust fund. Would you approve this trust fund or would you oppose it and permit wildlife populations to deteriorate to (the less-preferred situation)?"

Yes (approve) _____ No (oppose) _____

This wording minimizes (but does not entirely eliminate) problems of providing for exclusion of nonpayers in situations where license or access fees are inappropriate.

Option Price

The notion that people (including those who are not currently users of an amenity) might be willing to pay to reserve the option for future use, and that any WTP for this purpose counts as a benefit of securing future provision of the amenity, is well established. The term for this kind of value is "option price" (OP). It includes the expected consumer's surplus from future use (ES) and any risk premium or discount associated with uncertain future availability and uncertain future demand (option value, OV, which may be positive or negative). Thus, OP = ES + OV.

These definitions are important. There have been, as yet, no published empirical estimates of OV. Published estimates of OP have appeared for various amenities. However, what is really OP sometimes has been misidentified as OV. Ordinary discourse among nonspecialists tends to similarly confuse OP and OV. As Bishop (1982) and others have pointed out, summing current use values, OP and ES, is an erroneous procedure for calculating present and future use values. Correct procedures include: (1) adding current use value and OP; and (2) adding current use value, ES and OV. Procedure (1) is often used when future availability of the amenity is highly uncertain. For example, Brookshire et al. (in press) estimated OP for future hunting of species that are currently unavailable for hunting and species for which hunting opportunities are severely restricted. In both cases, future hunting opportunities must be considered highly uncertain. Procedure (2) is used (often in a truncated version in which OV is assumed to be zero) when future availability of the amenity is fairly well assured. ES is estimated from projections of future use and added to current use values. The assumption that OV is zero is not a source of great error in cases where supply risk is perceived as low.

347

To obtain WTP estimates of OP for hunting amenities, Brookshire et al. (in press) used a WTP question form based, in part, on the concept of the duck stamp project. An example follows, for an option for future hunting opportunities in the face of a threatened decline in game populations:

"Due to (whatever reason), populations of (species) are (or, are expected to become) so low that hunting is not permitted. Consider the following program to correct this situation and provide for future hunting opportunities. A (species) stamp program would be established to provide funds to preserve and extend (species) habitat. If the program is successful, hunting would be permitted again, starting (e.g., 10) years from now. People who purchase a stamp this year and annually for the next (10) years would be eligible to enter a lottery for a (species) hunting license each year after hunting was started. There would be a (e.g., 75%) chance of getting a license in any year. People who fail to buy this stamp would be ineligible to enter the lottery. If the (species) stamp cost $X, would you buy one?"

Yes _____ No _____

(Continue bidding routine.)

OP is also relevant for wildlife observation if population numbers and species diversity in future years are threatened.

Existence Value

Existence value is defined as the value of "just knowing . . . exists." To properly distinguish existence values from use values and OP's, existence values must be unrelated to current or expected future use. Past use, however, may enhance appreciation of the species or ecological community and thus increase existence value. Usually, existence value is defined to include values derived from altruism toward: others who might obtain use values; future generations who might obtain use values; and the species or community itself, out of concern for its well-being. Existence value is not confined to the global survival of species; existence of local or regional populations may be valued by some. Because existence value is not associated with use, the population of concerned persons may include some who do not live near, or visit, the impacted region.

As with observation value, existence value may be associated with individual species (by no means confined to game species) and ecological diversity. Existence values may be expected to reflect the quality dimension, in addition to the value of mere survival.

Because there is no plausible way to provide existence while excluding nonpayers, the trust fund and similar devices provide the only acceptable payment vehicles.

STEPS IN OBTAINING VALUE ESTIMATES WITH CONTINGENT VALUATION METHOD

Step 1 - Define the Increment or Decrement

    a.   Define the without project or baseline situation.

    b.   Define the with project situation.

    c.   Identify the increment or decrement in wildlife amenities that would be associated with implementation of the project. Identify the geographic range of affected territory. Identify the population of users (and those having existence values). Consider which of the following kinds of value are relevant: species hunting values; species observation values; ecosystem observation values; option price for hunting; option price for observation; species existence values; and ecosystem existence values. Explicitly consider the possibility that the project may affect values associated with nongame species and the integrity of ecosystems. Plan to implement contingency valuation procedures for each relevant kind of value (and for each user population, if these differ across the kinds of values).

Step 2 - Develop the Contingent Valuation Survey Instrument

    a.   Decide whether or not the survey is to be implemented in personal interviews or by mail. This decision will influence the design of the survey instrument.

    b.   Prepare a survey instrument. It should include:

- Introductory materials establishing the purpose, usefulness, legitimacy, and confidentiality of the survey. If the proposed project is controversial among the respondent population, it should not be explicitly or implicitly identified.

- Definition of the increment or decrement in wildlife amenities to be evaluated.

- The contingent market rules.

- The WTP question(s).

- Followup questions to identify protest bids.

- Demographic information to permit analysis of the relationship between individual WTP and socioeconomic and demographic characteristics.

- Any items that may be collected for purposes unrelated to CV.

    c.   Prepare related verbal, visual, or other stimuli that will assist in communication with respondents.

Step 3 - Pretest the Survey Instrument

All the usual considerations in pretesting apply. In addition, it is desirable to pretest several contingent markets, in order to identify any which generate unexpected resistance or confusion among respondents. Indicators of these problems are an unusual degree of hesitancy in responding and a high incidence of protest bids (usually interpreted to mean more than 15% of all bids).

Step 4 - Refine the Survey Instrument in Light of Pretest Performance

Step 5 - Draw the Survey Sample

Standard sampling procedures are to be used, modified by the considerations previously raised.

Step 6 - Conduct the Survey

Standard survey procedures are to be used. Particular attention should be paid to interviewer selection and training in the case of personal interview surveys. Contingent markets are a little different from many other kinds of surveys, and interviewers must be familiar and comfortable with them. Attention should also be paid to followup and other procedures to maximize response rate in the case of mail surveys.

Step 7 - Analyze the Data

a. Code the data and prepare it for data processing.

b. Identify protest bidders, record the frequency thereof, and separate their responses from the other responses. For research purposes, it may be interesting to conduct further analyses of protest bidders. However, all further analyses to estimate WTP are based on the nonprotest data set.

c. For maximum WTP bids:

(1) Unusually high bids can also be eliminated from the sample, to reduce the possibility that sample mean WTP is raised by confused respondents or those behaving strategically. There is no nonarbitrary rule for identifying unusually high bids. Published studies have eliminated high bids using various rules; e.g., the highest 2% of all nonprotest bids, all bids more than two standard deviations higher than the sample mean, all bids more than X percent of the respondent's household income. These procedures are usually defended on the grounds that they remove bids that "might" be unreliable and that any bias introduced by these procedures is toward conservative estimates of WTP.

(2) Sample mean bid and its standard error are calculated. The hypothesis that mean bid exceeds zero is tested statistically.

(3) If the relevant (impacted) population was sampled and random sampling procedures were used, aggregation proceeds by multiplying sample mean bid by the population size (number of licensed hunters who hunt in the affected area or the number of households in the affected area). Confidence limits can be calculated, using formulas provided in standard statistics textbooks. Aggregate WTP is the economic value of this particular increment in wildlife amenities provided, or decrement avoided, in the relevant contingent market.

(4) If a population sampled was other than that to be impacted by the proposed project, it is necessary to use a more complex aggregation procedure. Individual WTP (the dependent variable) is related to the demographic characteristics of the sample members (the independent variables) by multiple regression analysis. The result is an estimated WTP function. This function is used, along with data on the demographic characteristics of the affected population, to estimate mean WTP for the affected population. Estimated aggregate WTP is calculated by multiplying estimated mean WTP by population size.

(5) If desired, individual WTP can be statistically explained using regression analysis. This kind of analysis may enhance the understanding of what contributes to generating demands and values for wildlife amenities. It is an essential step if the results of a particular WTP survey will be generalized to other populations.

d. For responses to closed-ended questions [form (b) and (d)], the analysis is quite different. Responses are binary (yes or no). Nevertheless, estimates of aggregate consumers' surplus (aggregate WTP) can be generated using statistical analyses appropriate for discrete choice models. Bishop and Heberlein (1979), for example, used a logit analysis. Analysis of the relationship between yes/no responses and demographic characteristics of sample members also requires specialized statistical methods.

Step 8 - Estimate Total Wildlife Values

If the proposed project is expected to impact several sources of wildlife values (Step 1), the total effect of the project is calculated by summing aggregate WTP to obtain (or to avoid) the various increments (or decrements). Simple algebraic summation is adequate if the different sources of value have been carefully defined to avoid overlaps and double-counting.

Positive or negative signs are attached to each source of value. WTP to avoid a decrement indicates that the change is of negative value; WTP to gain an increment indicates that the change is of positive value. The total value of all the effects is the algebraic sum of the values of the various particular effects and may be positive or negative.

351

CONCLUDING COMMENTS

An adequate contingent valuation study to estimate total aggregate WTP for the effects of a proposed project on wildlife values is a considerable undertaking. Primary data collection, given adequate sample sizes, is expensive. The quality of the results is dependent on the time and effort available and the specialized human resources that can be invested in the undertaking. Inexperienced and inadequately trained personnel may inadvertently make crucial mistakes and errors of judgment. Unless the exercise withstands professional scrutiny and critique, its results will lack credibility. For these reasons, in cases where adequate resources simply cannot be assigned to the task, it may be desirable to abandon the contingency valuation method in favor of a modified unit day value approach.

APPENDIX L. INSTRUCTIONS FOR THE USE OF A MODIFIED UNIT DAY VALUE METHOD

GENERAL

The procedure, as suggested, is meant to be an evaluation framework through which the user derives his/her own values. However, sample values for both the consumptive (hunting) use of major categories of game species and a nonconsumptive user day (wildlife observation) were prepared based on a preliminary literature review. Development of site-specific values for both consumptive and nonconsumptive use-days is encouraged, and the procedures suggested should be undertaken by resource managers familiar with the specific impact areas.

The procedure is designed to allow the user to adjust the median values to reflect a specific impact area. All median values can be adjusted up or down, depending on the user's evaluation of six criteria that are generally accepted to be-key factors in determining differences in the use-day value of a given area. The criteria are access, crowding, aesthetic quality, family income (of users), education (of users), and annual cost (to users).

Positive or negative point scores are assigned to the study area based on these criteria, and scores are totaled. The total score is then multiplied by a dollar value per point, and this product (positive or negative) is added to the median recreation value. Dollar value per point will vary between consumptive and nonconsumptive recreation. The final use-day value for either type of recreation will be higher or lower than the median, depending on the quality of wildlife-associated recreation available in the study area.

The first three criteria (access, crowding, and aesthetic quality) are taken directly from the unit day value approach (U.S. Water Resources Council 1979). These variables may be very difficult to quantify, but experts generally agree that they are important determinants of recreation value. The next criterion, income of users, is important because recreation value or willingness to pay is closely linked with ability to pay, or income. The scales assigned to these variables are the same for each use. Education, the fifth criterion, is an unusual variable because increased educational level of users tends to be reflected in increased enjoyment (and, therefore, value) of nonconsumptive recreation but decreased enjoyment/value of consumptive recreation.

353

Annual cost is the sixth criterion for adjusting a median value. Annual costs for consumptive or nonconsumptive use recreation can be thought of as fixed and variable costs. Fixed costs include costs for all equipment, licenses, or fees necessary for participation in the activity (e.g., big game hunting). Another interpretation of fixed costs is all costs incurred before travel to the recreation experience begins. Fixed costs are positively related to the level of enjoyment or willingness to pay. Variable costs are the costs (food, lodging, and gasoline) related to a specific recreation trip. Indirectly, variable costs reflect distance to the destination for most users; distance usually accounts for 50% of the variable cost. The primary sources of data for user costs are individual State summaries from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior and U.S. Department of Commerce 1982).

In this procedure, it is assumed that annual costs can be used to adjust unit day values to reflect costs incurred by the average hunter or angler coming to the impact area for that recreation activity. Some States historically have had users who were willing to pay higher costs for recreation; i.e., higher costs than the National averages. The value of a recreation experience in such States could be adjusted upward on the basis of the annual cost criterion. Higher than average annual costs signify higher than average value for the recreation experience.

The six criteria are assigned points. Absence of information on any of the criteria means the user assigns a value of zero to that criterion. A dollar value is also assigned per point. Sample values per point are suggested, based on unit day value tables of the U.S. Water Resources Council (1979) and adjusted for the difference between the Water Resources Council study's median values and the median values in the current procedure.

INSTRUCTIONS

Step 1 - Select a median value for the category of game species under investigation, using Table L-1. These sample values were based on a review of 48 literature citations for unit day values. State or area specific values should be used if available.

Category: _____
Median value: $_____ per use-day

Step 2 - Estimate the point variation from the median value for the impact area. The median values in Step 1 can be adjusted for the impact area based on the quality of the recreational experience available for hunting or fishing, the characteristics of the average user in the area, and the historical annual costs incurred by users to participate in recreational opportunities in the area. This adjustment is a subjective judgment, and a point system was chosen to adjust the median value so that no single criterion has too great an impact. Shown below are the six criteria for impact area variation, with suggested point scores. Any criteria deemed inappropriate (e.g., due to the size of the project area) should be assigned a rating of zero. Judgment factors for determining ratings for each criterion are described in Table L-2.

Table L-1.   Average willingness to pay per day.

Category	Number of study values used	Value per day[a]
Big game:		
Deer	10	52.62
Elk	3	43.59
Deer and elk	3	48.57
Pronghorn	2	19.70
Moose	2	20.52
Grizzly bear	1	5.00
Bighorn sheep	2	12.77
Buffalo	1	21.92
All big game	4	76.95
Small game:		
Pheasant	2	65.07
Turkey	1	35.86
Mourning dove	1	41.24
Upland birds	1	43.03
All small game	4	39.60
Upland game:		
Small game mammals	1	20.48
Waterfowl:		
Ducks	1	55.05
Geese	3	7.03
All waterfowl	6	40.29
Predators:		
All predators	2	24.98
Freshwater Fishing:		
Bass	1	34.07
Trout and coho	7	16.69
Salmon and steelhead	7	53.60
Pike and walleye	1	55.58
Catfish	3	22.72
Panfish	1	34.07
Cold water	8	29.37
Warm water	4	54.05
All freshwater	2	19.75
Nonconsumptive		
Waterfowl	1.	1.22[b]
Animals	1	158.83[b]
Fish	1	130.52[b]
Birds	1	129.35[b]
All nonconsumptive	1	14.87

a   Each value is derived from reported values for category of
    concern. No reported study value appears in more than one
    category; e.g., all freshwater categories include only
    studies reporting values for all freshwater fishing. If
    desired, all major category values could be averaged with-
    out double counting individual study estimates; e.g.,
    freshwater fishing would yield $35.54/day.
b   Based on only one study, which was eliminated from averages
    for game categories when more than one study value ex-
    isted. Probably unreliable.

Source: Midwest Research Institute.

Table L-2. Judgment factors and point variations.

Criteria	Judgment factors				
1. Access factors =	Limited access by any means to site or within site	Poor access, poor quality roads to site, limited access within site	Fair access, fair road to site, fair access, good roads within site	Good access, good roads to site, fair access, good roads within site	Excellent access high standard road to site, good access within site
point value:	-7	-4	0	4	7
2. Crowding factors =	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users, rarely if ever crowded	Very low evidence of other users, never crowded
point value:	-15	-8	0	8	15
3. Aesthetic factors: =	Low aesthetic factors exist that significantly lower quality	Average aesthetic quality, factors exist that lower quality to minor degree	Above average aesthetic quality, any limiting factors can be reasonably rectified	High aesthetic quality, no factors exist that lower quality	Outstanding aesthetic quality, no factors exist that lower quality
point value:	-10	-5	0	5	10
4. Family income =	$14,000	$17,000	$20,000	$23,000	$26,000
point value:	-6	-3	0	3	6
5. Education (years) =	13.3	12.9	12.5	12.1	11.7
point value:	-9	-4.5	0	4.5	9
6. Annual cost ($) a. Big game ($) =	$165	$200	$236	$271	$307
point value:	-6	-3	0	3	6
b. Small game ($) =	$95	$115	$135	$155	$176
point value:	-6	-3	0	3	6
c. Waterfowl ($) =	$84	$102	$120	$138	$156
point value:	-6	-3	0	3	6
d. Hunting other animals ($) =	$67	$81	$95	$109	$124
point value:	-6	-3	0	3	6
e. Fishing - Cold water and warm water ($) =	$148	$180	$212	$244	$276
point value:	-6	-3	0	3	6

356

Criterion	Range	Point Score
Access	-7 to 7	_____
Crowding	-15 to 15	_____
Aesthetic quality	-10 to 10	_____
Family income	-6 to 6	_____
Education	-9 to 9	_____
Annual cost	-6 to 6	_____
Total	-53 to 53	_____

Step 3 - Determine the point adjusted median value (from Step 1) for the impact area and the category of evaluation species. Suggested monetary values per point variation are shown below for the six categories of game species.

Type	Value per point variation
Big game	$4.28
Small game	0.22
Waterfowl	0.15
General hunting	0.32
Cold water fishing	0.18
Warm water fishing	0.16

Total point score (Step 2)   Dollar value per point (above)

_____ x $_____ = $_____ Total point value
                        + $_____ Median value (Step 1)
                        = $_____ Point adjusted median value

357

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16. Abstract (Limit: 200 words)

This workbook provides a mechanism for analysis of human demographic impacts on fish and wildlife due to large-scale energy developments in Western States. It focuses on impacts related to land use conversions and the accompanying reduction in quantity or quality of habitat and on impacts related to population growth and their demands or impacts on fish and wildlife resources.

The workbook suggests procedures for projecting impacts on fish and wildlife resources, provides guidance on monetary valuation of resources potentially lost, and describes mitigation or enhancement measures.

The intended users are developers, resource managers, and planners. The workbook was designed for use with proposed coal or oil shale projects, but other energy development projects can be evaluated if projected work force requirements are known.

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Demographic   Energy
Wildlife   Resources
Fish   Population growth
Oilshale
Coal

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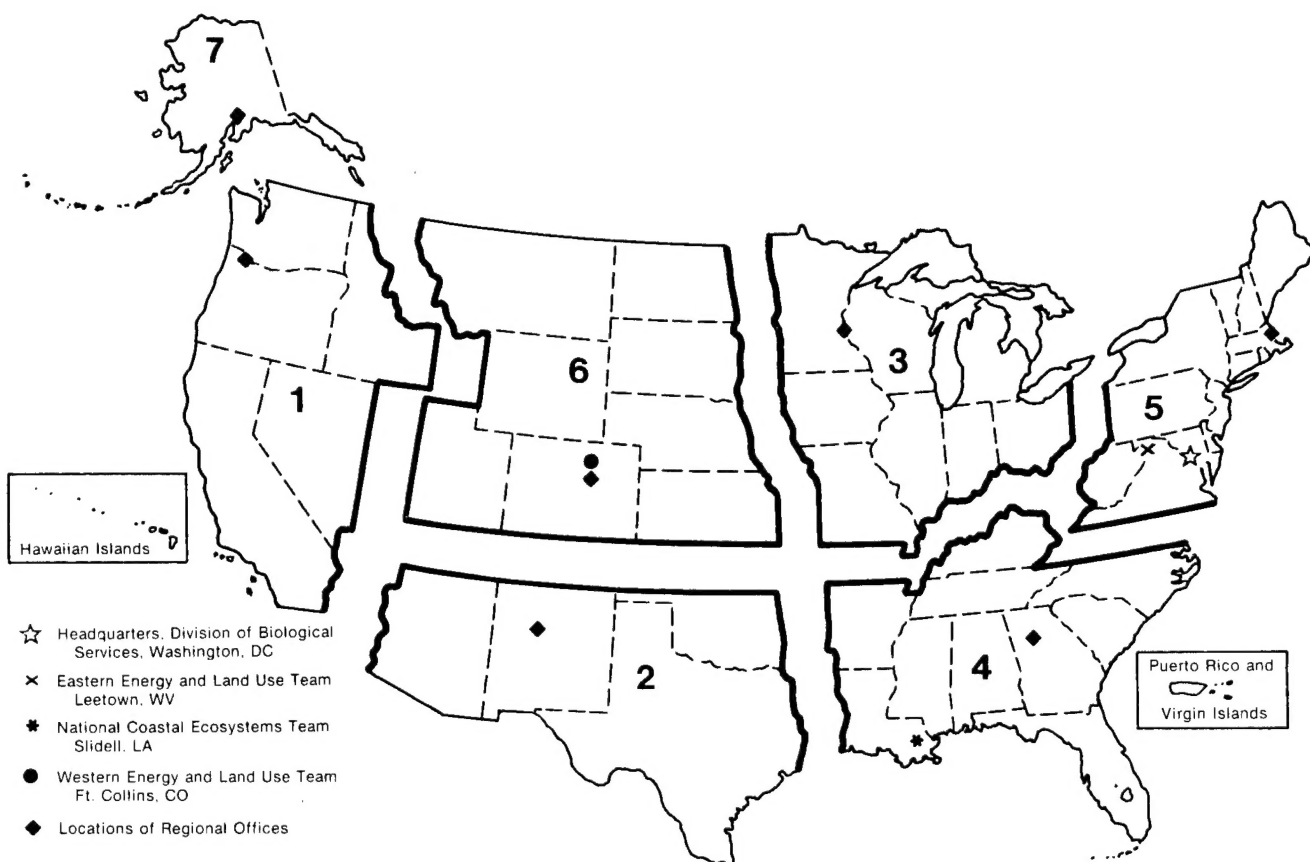
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